A LEVEL Cambridge Topical Past Papers

STATISTICS 2

2017 — 2023

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PURE MATHEMATICS P6 9709

TOPICAL PAST PAPER WORKSHEETS

2017 - 2023 | Questions + Mark scheme

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1 - (9709/72_Summer_2017_Q1) - *Hypothesis Testing Using Binomial Distribution, Hypothesis Testing Using Normal Distribution*

In a survey of 2000 randomly chosen adults, 1602 said that they owned a smartphone. Calculate an approximate 95% confidence interval for the proportion of adults in the whole population who own a smartphone. [4]

2 - (9709/73_Summer_2017_Q2) - *Hypothesis Testing Using Binomial Distribution, Hypothesis Testing Using Normal Distribution*

In a random sample of 200 shareholders of a company, 103 said that they wanted a change in the management.

(i) Find an approximate 92% confidence interval for the proportion, p, of all shareholders who want a change in the management. [3]

(ii) State the probability that a 92% confidence interval does not contain p. [1]

3 – (9709/72_Summer_2017_Q4) – *Hypothesis Testing Using Binomial Distribution*

It is claimed that 1 in every 4 packets of certain biscuits contains a free gift. Marisa and André both suspect that the true proportion is less than 1 in 4.

(i) Marisa chooses 20 packets at random. She decides that if fewer than 3 contain free gifts, she will conclude that the claim is not justified. Use a binomial distribution to find the probability of a Type I error. [2]

(ii) André chooses 25 packets at random. He decides to carry out a significance test at the 1% level, using a binomial distribution. Given that only 1 of the 25 packets contains a free gift, carry out the test. [5]

4 - (9709/71_Summer_2018_Q2) - *Hypothesis Testing Using Binomial Distribution, Hypothesis Testing Using Normal Distribution*

A six-sided die is suspected of bias. The die is thrown 100 times and it is found that the score is 2 on 20 throws. It is given that the probability of obtaining a score of 2 on any throw is p.

(i) Find an approximate 94% confidence interval for p. [3]

(ii) Use your answer to part **(i)** to comment on whether the die may be biased. [1]

5 - (9709/73_Summer_2018_Q3) - *Hypothesis Testing Using Binomial Distribution, Hypothesis Testing Using Normal Distribution*

A researcher wishes to estimate the proportion, p, of houses in London Road that have only one occupant. He takes a random sample of 64 houses in London Road and finds that 8 houses in the sample have only one occupant. Using this sample, he calculates that an approximate $\alpha\%$ confidence interval for p has width 0.130. Find α correct to the nearest integer. [5]

6 – (9709/72_Summer_2018_Q7) – *Hypothesis Testing Using Binomial Distribution*

A ten-sided spinner has edges numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Sanjeev claims that the spinner is biased so that it lands on the 10 more often than it would if it were unbiased. In an experiment, the spinner landed on the 10 in 3 out of 9 spins.

(i) Test at the 1% significance level whether Sanjeev's claim is justified. [5]

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(ii) Explain why a Type I error cannot have been made. [1]

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In fact the spinner is biased so that the probability that it will land on the 10 on any spin is 0.5.

(iii) Another test at the 1% significance level, also based on 9 spins, is carried out. Calculate the probability of a Type II error. [6]

7 - (9709/73_Winter_2018_Q2) - *Hypothesis Testing Using Binomial Distribution*

A headteacher models the number of children who bring a 'healthy' packed lunch to school on any day by the distribution $B(150, p)$. In the past, she has found that $p = \frac{1}{3}$. Following the opening of a fast food outlet near the school, she wishes to test, at the 1% significance level, whether the value of p has decreased.

(i) State the null and alternative hypotheses for this test. [1]

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On a randomly chosen day she notes the number, N, of children who bring a 'healthy' packed lunch to school. She finds that $N = 36$ and then, assuming that the null hypothesis is true, she calculates that $P(N \leqslant 36) = 0.0084$.

(ii) State, with a reason, the conclusion that the headteacher should draw from the test. [2]

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(iii) According to the model, what is the largest number of children who might bring a packed lunch to school? [1]

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ANSWERS

1 – (9709/72_Summer_2017_Q1) – *Hypothesis Testing Using Binomial Distribution, Hypothesis Testing Using Normal Distribution*

$\frac{0.801\times(1-0.801)}{2000}$ (= 0.0000797)	**M1**
$0.801\pm z\times\sqrt{\text{"}0.0000797\text{"}}$	**M1**
z = 1.96	**B1**
0.784 to 0.818 (3 sf)	**A1**
Total:	**4**

2 – (9709/73_Summer_2017_Q2) – *Hypothesis Testing Using Binomial Distribution, Hypothesis Testing Using Normal Distribution*

(i)	z = 1.751	**B1**
	$\frac{103}{200}\pm z\sqrt{\frac{\frac{103}{200}\times(1-\frac{103}{200})}{200}}$ oe	**M1**
	= 0.453 to 0.577 (3 sf) as final answer	**A1**
	Total:	**3**
(ii)	0.08 oe 8%, 8/100	**B1**

3 – (9709/72_Summer_2017_Q4) – *Hypothesis Testing Using Binomial Distribution*

(i)	$0.75^{20}+20\times0.75^{19}\times0.25+{}^{20}C_2\times0.75^{18}\times0.25^2$	**M1**
	= 0.0913	**A1**
	Total:	**2**
(ii)	H_0: Pop proportion=0.25 H_1: Pop proportion<0.25	**B1**
	$0.75^{25}+25\times0.75^{24}\times0.25$	**M1**
	= 0.00702	**A1**
	comp 0.01	**M1**
	There is evidence that the claim is not justified	**A1 FT**
	Total:	**5**

4 - (9709/71_Summer_2018_Q2) - *Hypothesis Testing Using Binomial Distribution, Hypothesis Testing Using Normal Distribution*

(i)	$\frac{20}{100} \pm z \times \sqrt{\frac{0.2\times(1-0.2)}{100}}$	M1	Any z
	$z = 1.881$ or 1.882	B1	
	$= 0.125$ to 0.275	A1	
		3	
(ii)	$\frac{1}{6}$ is within this range No evidence of bias concerning 2	B1ft	Both statements needed
		1	

5 - (9709/73_Summer_2018_Q3) - *Hypothesis Testing Using Binomial Distribution, Hypothesis Testing Using Normal Distribution*

	$\frac{\frac{8}{64}\times(1-\frac{8}{64})}{64}$ (= $\frac{7}{4096}$ or 0.00171)	M1	OE, e.g. $\frac{\frac{1}{8}\times\frac{7}{8}}{64}$
	$2 \times z\sqrt{"\frac{7}{4096}"} = 0.130$	M1	Correct equation using their variance
	$z = 1.572$	A1	
	$\phi("1.572")$ (= 0.942) (0.942 – (1 – 0.942) = 0.884)	M1	2ϕ(their z) -1
	$\alpha = 88$	A1	CAO
		5	

6 - (9709/72_Summer_2018_Q7) - *Hypothesis Testing Using Binomial Distribution*

(i)	H_0: P(10) = 0.1 H_1: P(10) > 0.1	B1	Both. Allow 'p' for P(10)
	B(9,0.1) $P(X \geqslant 3) =$ $1-(0.9^9 + 9\times0.9^8 \times 0.1 + {}^9C_2 \times 0.9^7 \times 0.1^2)$	M1	Allow one extra term in bracket
	= 0.05297... or 0.053(0)	A1	
	comp 0.01	M1	Valid comparison. (comparison with 0.99 can recover previous M1 A1 for 0.9470)
	No evidence (at 1% level) to reject H_0 Claim not justified	A1ft	No contradictions
		5	
(ii)	H_0 not rejected oe	B1	
		1	
(iii)	$P(X \geqslant 4)$ $= "0.05297" - {}^9C_3\times0.9^6\times0.1^3$	M1	or $1-(0.9^9 + 9 \times 0.9^8 \times 0.1 + {}^9C_2 \times 0.9^7 \times 0.1^2 + {}^9C_3 \times 0.9^6 \times 0.1^3)$
	= 0.00833	A1	Note: 0.05297 and 0.00833 both needed in (i) or (iii) to justify CV
	Hence crit value is 4	B1	Allow without working. Or in (i) May be implied by attempt at $P(X < 4)$ below
	B(9,0.5) $P(X < 4)$	M1	stated or implied
	$= 0.5^9 + 9 \times 0.5^8 \times 0.5 + {}^9C_2 \times 0.5^7 \times 0.5^2 + {}^9C_3\times0.5^6\times0.5^3$	M1	Attempt $P(X < 4)$ with $p = 0.5$
	P(Type II) = 0.254 (3 sf)	A1	
		6	

7 - (9709/73_Winter_2018_Q2) - *Hypothesis Testing Using Binomial Distribution*

(i)	$H_0: p = \frac{1}{3}$ $H_1: p < \frac{1}{3}$	**B1**	
		1	
(ii)	0.0084 < 0.01	**B1**	Allow P(N ⩽ 36) < 0.01 or 1%
	There is evidence that p has decreased	**B1 dep**	Allow 'p has decreased' or $p < \frac{1}{3}$
		2	
(iii)	150	**B1**	
		1	

8 - (9709/72_Winter_2018_Q6) - *Hypothesis Testing Using Normal Distribution, Hypothesis Testing Using Binomial Distribution*

(i)	$H_0: p = 0.15$ $H_1: p < 0.15$ (N(60 × 0.15, 60 × 0.15 × 0.85)) = N(9, 7.65)	**B1**	Accept $H_0: \mu = 9$ $H_1: \mu < 9$ Use of Normal approximation: (N(0.15, $\frac{0.15 \times 0.85}{60}$)) = N(0.15, 0.002125)
	$\frac{'6.5-9'}{\sqrt{'7.65'}}$	**M1**	For standardising (or $\frac{\frac{6}{60}+\frac{0.5}{60}-'0.15'}{\sqrt{'0.002125'}}$ = −0.904) Allow wrong or no cc
	= −0.904	**A1**	Accept ±
	'0.904' < 1.282	**M1**	Valid comparison of z values or ϕ('−0.904')= 0.183 > 0.1 ft their 0.904
	No evidence train late less often	**A1ft**	Use of Bin (60,0.15) to give Pr (< = 6) = 0.1848 M1A1 Valid comparison with 0.1 M1 Conclusion A1ft
		5	
(ii)	$0.1 + z \times \sqrt{\frac{0.1 \times 0.9}{60}} = 0.150$	**M1**	For √(0.1 × 0.9 / 60) seen
		M1	for 0.1 + z × ... = 0.150 or 2z… = 0.1
	z = 1.291	**A1**	
	ϕ('1.291') (= 0.90(16))	**M1**	for correct method to find α
	α = 80	**A1ft**	ft their z. Must be a +ve non-zero integer < 100
		5	

9 - (9709/73_Summer_2019_Q1) - *Hypothesis Testing Using Binomial Distribution*

	$0.6 \pm z\sqrt{\frac{0.4 \times 0.6}{100}}$	**M1**	Recognisable value of z
	z = 2.326	**B1**	2.326 to 2.329
	0.486 to 0.714 (3 sf)	**A1**	Must be an interval
		3	