



Mark Scheme (Results)

October 2020

Pearson Edexcel IAL In Statistics 1
Paper WST03/01

Question Number	Scheme	Marks
1.		
(a)	$E(2\bar{X}) = 2E(\bar{X}) = \frac{2(1+\alpha)}{2}$	M1
	$= 1 + \alpha \neq \alpha$ (therefore $2\bar{X}$ is a biased estimator of α)	A1
		(2)
(b)	$\bar{x} = 6 \quad 2\bar{x} - 1 =$	M1
	<u>11</u>	A1
		(2)
		Total 4
	Notes	
(a)	<p>M1 for use of $2 \times \frac{1+\alpha}{2}$</p> <p>Also correct comparison with α and no incorrect working seen.</p> <p>$\frac{1+\alpha}{2} \neq \alpha$ is M0A0</p>	
(b)	<p>M1 for attempt at \bar{x} and use of $2\bar{x} - 1$ or ft use of their $E(\bar{X})$ from part (a) to find an estimate for α</p> <p>A1 11 cao</p>	

Question Number	Scheme					Marks
2. (a)						
	Expected values: 13.75, 19.25, 17					B1
	$\frac{(18-13.75)^2}{13.75} \quad \frac{(15-19.25)^2}{19.25} \quad \frac{(17-17)^2}{17}$					M1
	Pass	1.31	0.94	0	2.25	
					9.43	A2
(b)	H_0 : <u>Degree/category</u> is independent of <u>department</u> (no association) H_1 : Degree/category is not independent of department (association)					B1
	$\nu = (3-1)(3-1) = 4$					B1
	$\chi^2_4(5\%) = 9.488$					B1ft
	'9.43' < 9.488, so do not reject H_0 / not significant					M1
	Not enough evidence to show that the Degree/category is not independent of department (no association) (at the 5% level of significance)					A1ft
						(5)
						Total 9
Notes						
(a)	B1 All correct expected values (may be implied by A2) M1 Attempting $\frac{(O-E)^2}{E}$ for their E (may be implied by one correct value) A2 all 5 values correct (allow awrt) (A1 any 2 values correct)					
(b)	B1 Both hypotheses required must mention degree/category and department at least once. Use of “relationship” or “correlation” or “connection” or “link” award B0. B1 4 can be implied by 9.488 seen B1ft 9.488 or better. Follow through their ν so may see $\chi^2_{3,0.05} = 7.815$ $\chi^2_{2,0.05} = 5.991$ M1 Correct non-contextual conclusion for their (a) and c.v. Can be implied by correct conclusion in context ft their (a) and c.v. A1ft A correct comment in context. Condone “relationship” or “connection” here but not “correlation”. Follow through from their test statistic and cv, but hypotheses must be correct.					

Question Number	Scheme	Marks
3. <		

Question Number	Scheme	Marks																												
4. (a)	Randomly select a student from 1 to 7 oe	B1																												
	Take every 7 th student	B1																												
		(2)																												
(b)	$\nu = 10 - 1 = 9$ $\chi^2_9(10\%) = 14.684$	B1 B1ft																												
	No evidence (at 10% level of significance) that the digits generated do not follow a uniform distribution .	dB1																												
		(3)																												
(c)	H_0 : Uniform distribution is a good fit (for the two-digit numbers generated) H_1 : Uniform distribution is not a good fit (for the two-digit numbers generated)	B1																												
	<table><tr><td>O</td><td>E</td><td>$\frac{(O-E)^2}{E}$</td><td>$\frac{O^2}{E}$</td></tr><tr><td>31</td><td>40</td><td>2.025</td><td>24.025</td></tr><tr><td>49</td><td>40</td><td>2.025</td><td>60.025</td></tr><tr><td>30</td><td>40</td><td>2.5</td><td>22.5</td></tr><tr><td>42</td><td>40</td><td>0.1</td><td>44.1</td></tr><tr><td>48</td><td>40</td><td>1.6</td><td>57.6</td></tr><tr><td>200</td><td>200</td><td>8.25</td><td>208.25</td></tr></table>	O	E	$\frac{(O-E)^2}{E}$	$\frac{O^2}{E}$	31	40	2.025	24.025	49	40	2.025	60.025	30	40	2.5	22.5	42	40	0.1	44.1	48	40	1.6	57.6	200	200	8.25	208.25	B1 M1 A1
	O	E	$\frac{(O-E)^2}{E}$	$\frac{O^2}{E}$																										
	31	40	2.025	24.025																										
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	48	40	1.6	57.6																										
	200	200	8.25	208.25																										
	$\sum \frac{(O-E)^2}{E} = 8.25$ or $\sum \frac{O^2}{E} - 200 = 8.25$	A1																												
$\chi^2_4(10\%) = 7.779$	B1																													
[8.25 > 7.779] Reject H_0 / Significant	M1																													
There is evidence to suggest the two-digit numbers generated may not follow a uniform distribution .	A1																													
	(8)																													
(d)	To generate a simple random sample, Luka would need to generate two-digit numbers (from 00 to 69)	B1																												
	But Luka's table would not be suitable for generating random two-digit numbers	B1ft																												
		(2)																												
		Total 15																												
Notes																														
(a)	B1 for the idea of generating a random number to determine first student selected																													
(b)	B1 for every 7th student (not just select 40 students)																													
	B1 for correct degrees of freedom (may be implied by 2 nd B1)																													
	B1ft for correct critical value 14.684 or better ft their d.f. so may see $\chi^2_{10}(10\%) = 15.987$																													
(c)	B1 (dependent upon 2 nd B1) for correct conclusion in context with digits (oe) and uniform distr.																													
	B1 Both hypotheses correct																													
	B1 All expected values = 40																													
	M1 Attempting $\frac{(O-E)^2}{E}$ or $\frac{O^2}{E}$ with at least 3 correct (1 dp truncated or rounded) or f.t. their E																													
	A1 all $\frac{(O-E)^2}{E}$ or $\frac{O^2}{E}$ correct (1 dp truncated or rounded). May be implied by 8.25 or 208.25																													
	A1 8.25 oe																													
	B1 correct critical value 7.779 or better																													
	M1 for a correct non-contextual conclusion (ignore any contradictory contextual comments for this mark) based on their cv and their test statistic																													
	A1 correct conclusion in context with all previous marks scored																													
(d)	B1 for the idea of generating two-digit numbers (for a simple random sample)																													
	B1ft Luka's table not suitable for generating two-digit random numbers for a simple random sample, ft parts (b) and (c)																													
SC:	If B0B0 scored, 'table only suitable for generating one-digit random numbers' scores B0B1																													

Question Number	Scheme	Marks
5.		
(a)	$s_A^2 = \frac{1}{39}(790258 - 140.4^2 \times 40) \quad s_B^2 = \frac{1}{31}(581430 - 134.7^2 \times 32)$ $= 45.4256.... \quad \text{awrt 45.4} \quad = 26.4232... \quad \text{awrt 26.4}$	M1 A1 A1 (3)
(b)	$H_0 : \mu_A - \mu_B = 5$ $H_1 : \mu_A - \mu_B > 5$ $s.e. = \sqrt{\frac{45.4256...}{40} + \frac{26.4232...}{32}} \quad (= \text{awrt 1.4})$ $z = \frac{\pm(140.4 - 134.7 - 5)}{s.e.} = \text{awrt 0.50}$ $c.v. = 1.6449$ (Do not reject H_0) Insufficient evidence to support the greengrocer's belief . (Insufficient evidence that the difference in weight between type A oranges and type B oranges is over 5 grams).	B1 B1 M1 dM1 A1 B1 A1ft (7)
(c)	Large sample sizes so... Sample means are normally distributed (CLT) $s_A^2 = \sigma_A^2 \quad \text{and} \quad s_B^2 = \sigma_B^2$	 B1 B1 (2)
	Notes	Total 12
(a)	M1 one correct expression A1 either awrt 45.4 or awrt 26.4 A1 both awrt 45.4 and awrt 26.4	
(b)	B1 Allow equivalent rearrangements. Must use μ B1 Allow equivalent rearrangements. Must use μ . For both hypotheses do not allow e.g. μ_1 and μ_2 unless each has been clearly defined M1 attempt at standard error (allow one slip) ft their (a) dM1 standardising with $(140.4 - 134.7 - 5)$ and their s.e. (dep on previous M1) A1 for 0.5 or awrt 0.50 B1 correct c.v. 1.6449 or better. Allow -1.6449 or better with use of $\mu_B - \mu_A$ Allow $p = \text{awrt 0.309}$ A1ft correct ft conclusion in context with either greengrocer's belief (oe) or difference in weights (oe) dependent on all B and M marks scored.	
(c)	B1 must comment on both sample means, \bar{A} and \bar{B} B1 must comment on both variances/standard deviations	

Question Number	Scheme	Marks
6.		
(a)	$\bar{T} \sim N(4, \frac{4}{35})$	M1 A1
		(2)
(b)	$\bar{K} \sim N(\lambda, \frac{\lambda}{40})$	M1
	$2 \times 2.5758 \times \sqrt{\frac{\lambda}{40}} = 2.6$	B1 M1
	$\lambda = \text{awrt } \underline{10.2}$	A1
		(4)
(c)	$2 \times 0.99 \times 0.01$	M1
	$= \underline{0.0198}$	A1
		(2)
		Total 8
	Notes	
(a)	M1 for Normal distribution A1 for correct mean and variance (allow N(4, awrt 0.114))	
(b)	M1 for use of $\frac{\lambda}{40}$ if $\lambda = \sigma$ is used, then M0 B1 for ± 2.5758 (may be implied by sight of 10.188...) M1 for use of $2 \times z \times \frac{\sigma'}{\sqrt{40}} = 2.6$ with $ z > 2$ A1 awrt 10.2 (an answer of 10.15...or awrt 10.2 on its own scores M1B0M1A1) SC: Use of $\sqrt{\lambda}$ instead of λ leading to an answer of awrt 3.19... scores M0B1M1A0	
(c)	M1 for $2p(1-p)$ for any p $0 < p < 1$ A1 0.0198	

Question Number	Scheme	Marks
7. (a)		
	$C_1 + C_2 + C_3 \sim N(480, 3 \times 1.25^2)$	M1 A1
	$P(C_1 + C_2 + C_3 > 475.8) = P\left(Z > \frac{475.8 - 480}{\sqrt{3 \times 1.25^2}} (= -1.94)\right)$	M1
	= awrt 0.974	A1
		(4)
(b)	$W = T_1 + T_2 + T_3 + T_4 + T_5 + C_1 + C_2 \sim N(5 \times 60 + 2 \times 160, 5 \times 2^2 + 2 \times 1.25^2)$	M1 A1
	$P(W > 625) = P\left(Z > \frac{625 - 620}{\sqrt{23.125}} (= 1.03975...)\right)$	M1
	= awrt 0.149	A1
		(4)
(c)	$Y = (n-1)T_1 - \sum_{r=2}^n T_r$	
	$Y \sim N(\mu, \sigma^2)$	
	$\mu = (n-1) \times 60 - (n-1) \times 60 [= 0]$	M1 A1
	$\sigma^2 = (n-1)^2 \times 4 + (n-1) \times 4 [= 4n^2 - 4n]$	M1 A1
	$\frac{40-0}{\sqrt{4n^2 - 4n}} = 1.38$	M1 B1
	$4n^2 - 4n - 840(.159...) = 0$	dM1
	$n = 15$	A1
		(8)
		Total 16
	Notes	
(a)	M1 for setting up Normal distribution with mean 480 A1 for correct expression for variance (= 4.6875) or for standard deviation (= 2.165...) M1 standardising with 475.8, 480 and their standard deviation (their standard deviation \neq 3.75) A1 awrt 0.974	
(b)	M1 for setting up Normal distribution with mean 620 A1 for correct expression for variance (= 23.125) or for standard deviation (= 4.8088...) M1 standardising with 625, 620 and their standard deviation A1 awrt 0.149	
(c)	M1 for a single combined normal distribution (may be implied by a single standardisation) A1 correct expression for μ M1 for use of $a^2 \times 4 + a \times 4$ A1 correct expression for σ^2 M1 standardising with their mean and their sd = z where $1 < z < 1.5$ B1 awrt 1.38 dM1 solving their 3TQ (working must be shown if answer is incorrect) (dependent upon 2 nd M1) A1 15 cao (must reject -14 if found). Must come from compatible signs in standardisation.	