

# Mark Scheme (Results)

Summer 2016

Pearson Edexcel GCE Statistics S3 (6691/01)



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## **General Marking Guidance**

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

### **PEARSON EDEXCEL GCE MATHEMATICS**

#### **General Instructions for Marking**

- 1. The total number of marks for the paper is 75
- 2. The Edexcel Mathematics mark schemes use the following types of marks:
  - **M** marks: Method marks are awarded for 'knowing a method and attempting to apply
  - it', unless otherwise indicated.

• A marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.

- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.
- 3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod benefit of doubt
- ft follow through
- the symbol  $\sqrt{}$  will be used for correct ft
- cao correct answer only
- cso correct solution only. There must be no errors in this part of the question to obtain this mark
- isw ignore subsequent working
- awrt answers which round to
- SC: special case
- oe or equivalent (and appropriate)
- d... or dep dependent
- indep independent
- dp decimal places
- sf significant figures
- \* The answer is printed on the paper or ag- answer given
- \_ or d... The second mark is dependent on gaining the first mark
- 4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

- 5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.
- 6. If a candidate makes more than one attempt at any question:
  - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
  - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.
- 7. Ignore wrong working or incorrect statements following a correct answer.

# June 2016 6691 Statistics S3 Mark Scheme

Question Number	Scheme	Marks
1(a) e.g.	Analyse / find estimates for a particular <b>subgroup</b> of the population.	
	Stratified guarantees <b>representation</b> of all <b>groups</b> , srs does not.	
	Observe <b>relationships between subgroups</b> – srs does not guarantee equal or proportionate representation.	
	Rare or extreme cases as part of a <b>small subgroups</b> can be represented <b>proportionately</b> in stratified i.e. stratified represents the structure of the population– srs does not allow this.	
	Stratified typically require <b>large sample size</b> compared to srs due to lower variability within subgroups compared to entire population.	
	Any 2 distinct reasons	B1B1
		(2)
(b) e.g.	It (a stratified sample) is <b>not biased</b> as the members are chosen randomly.	
	You can <b>estimate the sampling errors</b> (for a stratified sample)	
	It (a stratrified sample) gives <b>more accurate estimates</b> as it is a random process.	
	A quota sample may be (interviewer / process) biased.	
	It's <b>not possible to estimate/find the sampling errors</b> for a quota sample (whereas you can for a stratified sample)	
	(whereas you can for a stratified sample) Any 2 distinct reasons	B1B1
		(2)
		Total 4
Notes	Award B1B1 two correct, B1B0 one correct.	
	Allow 'it' for 'stratified'.	
	Do not award marks for vague responses such as 'cheap', 'easy' 'quick' 'random' etc.	
	Mentioning 'sampling frame' alone is not sufficient for a mark.	
	Mentioning 'non-response are not recorded' alone is not sufficient for a mark.	

Question Number		Scheme				Marks		
2	H <sub>0</sub> : Drug concer	ntration and catching	influenza are independ	ent / not associated				
	$H_1$ : Drug concentration and catching influenza are not independent / associated							
		A	В	С				
	Influenza	$\frac{50 \times 27}{110} = 12.272$	$\frac{50 \times 52}{110} = 23.636$	$\frac{50 \times 31}{110} = 14.090$ 50				
	No influenza	$\frac{60 \times 27}{110} = 14.727$	$\frac{60 \times 52}{110} = 28.363$	$\frac{60 \times 31}{110} = 16.909$	60	M1A1		
		27	52	31	110			
		27	52	51	110			
	0	E	$(O-E)^2$	$O^2$				
			E	E				
	12	12.272	0.0060	11.7333				
	9	14.090	1.21/1	5 7483				
	15	14.727	0.0050	15.2777				
	23	28.363	1.0142	18.6506		M1A1		
	22	16.909	1.5327	28.6236				
	$\sum \frac{(O-E)^2}{E} = 5.6145 \text{ or } \sum \frac{O^2}{E} - N = 115.62 110 = 5.6145 \text{ awrt } 5.61-5.62$ $v = (3-1)(2-1) = 2$ , $\chi_2^2 (10\%) = 4.605$ Reject H <sub>0</sub> <b>Drug concentration</b> and catching <b>influenza</b> are not independent / are associated.							
Nata	D1 Laure data	1				Total 10		
Inotes	BI nyps correct way around							
	MI for correct exp	pression at least once						
	A1 all seen and co	rrect 2dp or better. Ca	n be implied by test sta	tistic of awrt 5.61-5.6	2.			
	M1 either method at least one correct A1 at least 3 correct values. Can be implied by test statistic of awrt 5.61-5.62							
	A1 awrt 5.61-5.62							
	B1 cao							
	B1 follow through	their v						
	M1 must correctly	reject / not reject the i	null hypothesis based or	n their test stat and cv	v oe			

3 (a)       Vuriables do not have a (joint) normal distribution Relationship is not linear The given data is ordinal       Any 1         (b) $\boxed{Day}$ Sun       Mon       Tues       Weds       Thurs       Fri       Sat         (a) $\boxed{Day}$ Sun       Mon       Tues       Weds       Thurs       Fri       Sat         (b) $\boxed{Day}$ Sun       Mon       Tues       Weds       Thurs       Fri       Sat $\boxed{Day}$ Sun $6$ 4       7       5       3       2       1 $\boxed{Max}$ $\boxed{Cc-cream}$ $6$ 4       7       5       3       2       1 $\boxed{Max}$ $\boxed{Cc-cream}$ $6$ 4       7       5       3       2       1 $\boxed{Max}$ $\boxed{Cc-cream}$ $6$ 4       7       2       3       4       1 $\boxed{Max}$ $\boxed{Cc-cream}$ $\boxed{0}$ $1$ $0$ $9$ $0$ $4$ $0$ $\boxed{Max}$ $\boxed{Cc-cream}$ $\boxed{Ca-cream}$ $\boxed{Max}$ $\boxed{Max}$ $\boxed{Max}$ $\boxed{Max}$ $\boxed{Max}$ $\boxed{Max}$ $\boxed{Max}$ $\boxed{Max}$	Question Number			Scher	ne					Mark	KS
	3 (a)	Variables do not have a (joint) normal distribution									
(b) $\boxed{\begin{array}{ c c c c } \hline Day & Sun & Mon & Tues & Weds & Thurs & Fri & Sat \\ \hline \hline Ice-cream & 6 & 4 & 7 & 5 & 3 & 2 & 1 \\ \hline Sunglasses & 6 & 5 & 7 & 2 & 3 & 4 & 1 \\ \hline d & 0 & -1 & 0 & 3 & 0 & -2 & 0 \\ \hline d^2 & 0 & 1 & 0 & 9 & 0 & 4 & 0 \\ \hline \hline D^2 & 2 & 14 & & \\ \hline r_i & = 1 - \frac{6 \times 14}{7(49 - 1)} = 0.75 & & & \\ \hline Ice & Frider & Frider & Frider & Frider & Frider & \\ \hline Ice & Frider & Frider & Frider & \\ \hline D^2 & 2 & 0 & 1 & 0 & 9 & 0 & 4 & 0 \\ \hline D^2 & 2 & 14 & & \\ \hline T_i & = 1 - \frac{6 \times 14}{7(49 - 1)} = 0.75 & & & \\ \hline Ice & Frider & Frider & \\ \hline Ice & Frider & Frider & \\ \hline Ice & \\$		Relationship is not linearThe given data is ordinalAny 1									(1)
$ \begin{vmatrix} \frac{\text{ke-cream}}{\text{Sunglasses}} & 6 & 4 & 7 & 5 & 3 & 2 & 1 \\ \hline \text{Sunglasses}} & 6 & 5 & 7 & 2 & 3 & 4 & 1 \\ \hline d & 0 & -1 & 0 & 3 & 0 & -2 & 0 \\ \hline d^2 & 0 & 1 & 0 & 9 & 0 & 4 & 0 \\ \hline \hline d^2 & 0 & 1 & 0 & 9 & 0 & 4 & 0 \\ \hline \hline d^2 & 0 & 1 & 0 & 9 & 0 & 4 & 0 \\ \hline \hline \lambda^2 & -14 & & & & & & & & \\ r, = 1 - \frac{6 \times 14}{7(49-1)} = 0.75 & & & & & & & & & & \\ \text{MIA1} \\ r, = 1 - \frac{6 \times 14}{7(49-1)} = 0.75 & & & & & & & & & & \\ \text{Sweev 0.7143} & & & & & & & & & & \\ \text{Rcject H}_0 & & & & & & & & & & & \\ \text{Evidence of positive correlation between sales of ice cream and sales of sunglasses. & & & & & & \\ \text{(d)} & & & & & & & & & & & & \\ \text{Sweev 0.6694} & & & & & & & & & & \\ \text{Accept H}_0 & & & & & & & & & & & \\ \text{Accept H}_0 & & & & & & & & & & & \\ \text{Insufficient evidence of positive correlation between sales of ice cream and sales of sunglasses. & & & & & & \\ \text{(e)} & & & & & & & & & & & & \\ \text{Suggests relationship might be non-linear. & & & & & & & & \\ \text{(e)} & & & & & & & & & & & & & \\ \text{Suggests relationship might be non-linear. & & & & & & & & \\ \text{(f)} & & & & & & & & & & & & & \\ \text{Notes} \\ \text{(a)} & & & & & & & & & & & & & & & & & & \\ Accept 'already ranked' oe for ordinal & & & & & & & & & & & & & \\ \text{Accept already ranked' oe for ordinal & & & & & & & & & & & & & \\ \text{Accept already ranked' oe for ordinal & & & & & & & & & & & & & & & & \\ \text{Accept already ranked' oe for ordinal & & & & & & & & & & & & & & & & & & &$	(b)	Day	Sun	Mon	Tues	Weds	Thurs	Fri	Sat		
$\begin{bmatrix} \frac{\operatorname{Sunglasses}{\operatorname{rank}} & 6 & 5 & 7 & 2 & 3 & 4 & 1 \\ \hline d & 0 & -1 & 0 & 3 & 0 & -2 & 0 \\ \hline d^2 & 0 & 1 & 0 & 9 & 0 & 4 & 0 \\ \hline \\$		Ice-cream	6	4	7	5	3	2	1		
$ \begin{pmatrix} d & 0 & -1 & 0 & 3 & 0 & -2 & 0 \\ \hline d^2 & 0 & 1 & 0 & 9 & 0 & 4 & 0 \\ \hline \Sigma d^2 = 14 & & & & & & & & & & \\ r_{*} = 1 - \frac{6 \times 14}{7(49 - 1)} = 0.75 & & & & & & & & & & & & & & & & & & &$		Sunglasses rank	6	5	7	2	3	4	1		
$\begin{bmatrix} d^2 & 0 & 1 & 0 & 9 & 0 & 4 & 0 \\ \hline D d^2 = 14 & & & & & & & & & & & & & & & & & & $		d	0	-1	0	3	0	-2	0		
$ \begin{array}{c} \sum d^2 = 14 \\ \hline \\ \sum d^2 = 14 \\ \hline \\ \hline \\ \sum d^2 = 14 \\ \hline \\ \hline \\ \sum d^2 = 14 \\ \hline \\ M1 \\ M1A1 \\ \hline \\ M1A1 \\ B1 \\$		$d^2$	0	1	0	9	0	4	0		
$r_i = 1 - \frac{6 \times 14}{7(49 - 1)} = 0.75$ M1A1(c) $H_0: \rho = 0, H_1: \rho > 0$ B1 $5\% cv 0.7143$ B1Reject $H_0$ M1Evidence of positive correlation between sales of ice cream and sales of sunglasses.A1cao(d) $(5\% cv 0.6694)$ M1Accept $H_0$ M1Insufficient evidence of positive correlation between sales of ice cream and sales ofA1cao(e)Suggests relationship might be non-linear.(2)(a)Accept 'already ranked' oe for ordinal Accept one variable is not normally distributed $\Delta^2 = 14$ (b)M1 attempt to find $d, d^2$ and sum. may be implied by sight of $\sum d^2 = 14$ M1 for use of the correct formula, follow through their $\sum d^2$ if clearly stated. If answer is not correct, a correct expression is required. A1 0.75 caoIst B1for both hypotheses in terms of $\rho$ , one tail. Allow use of $\rho_x$ . Only award if no errors seen in hypotheses in part(c) and part(d) Hypothese just in words e.g. "no correlation" score B0. B1 0.7143 caoM1 must correctly reject / not reject the null hypothesis based on their test stat and cv oe A1 Conclusion must mention ice cream and suglasses(d)M1 for not rejecting null hyp A1 must mention ice cream and suglasses		$\sum d^2 = 14$	1		I	I		I		M1	
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5% ev 0.7143B1Reject $H_0$ M1Evidence of positive correlation between sales of ice cream and sales of sunglasses.Alcao (4)(d)(5% ev 0.6694) Accept $H_0$ M1Insufficient evidence of positive correlation between sales of ice cream and sales of sunglasses.Alcao (2)(e)Suggests relationship might be non-linear.B1(i)Total 11Notes (a)Accept 'already ranked' oe for ordinal Accept one variable is not normally distributed $\sum d^2 = 14$ (1) Total 11(b)M1 attempt to find $d$ , $d^2$ and sum, may be implied by sight of $\sum d^2 = 14$ M1 for use of the correct formula, follow through their $\sum d^2$ if clearly stated. If answer is not correct, a correct expression is required. A1 0.75 caoIst B1for both hypotheses in terms of $\rho$ , one tail. Allow use of $\rho_1$ . Only award if no errors seen in hypotheses in part(c) and part(d) Hypotheses just in words e.g. "no correlation" score B0. B1 0.7143 cao M1 must correctly reject / not rejecting null hyp A1 must mention ice cream and sunglassesIst B1 for both hypotheses in part(c) and part(d) Hypothese fust in words e.g. "no correlation" score B0. B1 0.7143 caoIn ust mention ice cream and sunglasses	(c)	$H_0: \rho = 0, H$	$\mathbf{H}_{1}: \boldsymbol{\rho} > 0$	)						B1	(3)
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Accept one variable is not normally distributed(b)M1 attempt to find $d$ , $d^2$ and sum. may be implied by sight of $\sum d^2 = 14$ M1 for use of the correct formula, follow through their $\sum d^2$ if clearly stated. If answer is not correct, a correct expression is required. A1 0.75 cao(c)1st B1for both hypotheses in terms of $\rho$ , one tail. Allow use of $\rho_s$ .Only award if no errors seen in hypotheses in part(c) and part(d) Hypotheses just in words e.g. "no correlation" score B0. B1 0.7143 cao(d)M1 for not reject / not reject the null hypothesis based on their test stat and cv oe A1 Conclusion must mention ice cream and sunglasses(d)M1 for not rejecting / accepting null hyp A1 must mention ice cream and sunglasses	(a)	Accept 'alread	y ranked'	oe for ordin	al						
(b) M1 attempt to find $d$ , $d^2$ and sum. may be implied by sight of $\sum d^2 = 14$ M1 for use of the correct formula, follow through their $\sum d^2$ if clearly stated. If answer is not correct, a correct expression is required. A1 0.75 cao (c) 1st B1 for both hypotheses in terms of $\rho$ , one tail. Allow use of $\rho_s$ . <b>Only award</b> if no errors seen in hypotheses in part(c) <b>and part(d)</b> Hypotheses just in words e.g. "no correlation" score B0. B1 0.7143 cao M1 must correctly reject / not reject the null hypothesis based on their test stat and cv oe A1 Conclusion must mention ice cream and sunglasses (d) M1 for not rejecting / accepting null hyp A1 must mention ice cream and sunglasses	(1-)	Accept one var	riable is n	ot normally	distributed						
(c) M1 for use of the correct formula, follow through their $\sum d^2$ if clearly stated. If answer is not correct, a correct expression is required. A1 0.75 cao (c) 1st B1for both hypotheses in terms of $\rho$ , one tail. Allow use of $\rho_s$ . <b>Only award</b> if no errors seen in hypotheses in part(c) <b>and part(d)</b> Hypotheses just in words e.g. "no correlation" score B0. B1 0.7143 cao M1 must correctly reject / not reject the null hypothesis based on their test stat and cv oe A1 Conclusion must mention ice cream and sunglasses (d) M1 for not rejecting / accepting null hyp A1 must mention ice cream and sunglasses	(b)	M1 attempt to	find $d$ , $c$	$d^2$ and sum.	may be impl	ied by sight o	of $\sum_{n=1}^{\infty} d^2 =$	14			
(c) answer is not correct, a correct expression is required. A1 0.75 cao (c) 1st B1for both hypotheses in terms of $\rho$ , one tail. Allow use of $\rho_s$ . <b>Only award</b> if no errors seen in hypotheses in part(c) <b>and part(d)</b> Hypotheses just in words e.g. "no correlation" score B0. B1 0.7143 cao M1 must correctly reject / not reject the null hypothesis based on their test stat and cv oe A1 Conclusion must mention ice cream and sunglasses (d) M1 for not rejecting / accepting null hyp A1 must mention ice cream and sunglasses		M1 for use of	the corre	ect formula	, follow thro	bugh their $\sum_{i=1}^{n}$	$\int d^2$ if cle	arly state	d. If		
(c)1st B1for both hypotheses in terms of $\rho$ , one tail. Allow use of $\rho_s$ .Only award if no errors seen in hypotheses in part(c) and part(d) Hypotheses just in words e.g. "no correlation" score B0. B1 0.7143 caoM1 must correctly reject / not reject the null hypothesis based on their test stat and cv oe A1 Conclusion must mention ice cream and sunglasses(d)M1 for not rejecting / accepting null hyp A1 must mention ice cream and sunglasses		answer is not A1 0.75 cao	correct, a	a correct ex	pression is	required.					
Only award if no errors seen in hypotheses in part(c) and part(d)Hypotheses just in words e.g. "no correlation" score B0.B1 0.7143 caoM1 must correctly reject / not reject the null hypothesis based on their test stat and cv oeA1 Conclusion must mention ice cream and sunglasses(d)M1 for not rejecting / accepting null hypA1 must mention ice cream and sunglasses	(c)	1st B1for both	hypothes	es in terms c	of $\rho$ , one tail.	Allow use of	$f \rho_s$ .				
M1 must correctly reject / not reject the null hypothesis based on their test stat and cv oeA1 Conclusion must mention ice cream and sunglasses(d)M1 for not rejecting / accepting null hypA1 must mention ice cream and sunglasses		Hypotheses just B1 0.7143 cao	st in word	seen in hyp s e.g. "no cc	otheses in pa orrelation" sc	rt(c) and pail ore B0.	rt(d)				
A1 Conclusion must mention ice cream and sunglasses         (d)       M1 for not rejecting / accepting null hyp         A1 must mention ice cream and sunglasses		M1 must corre	ctly reject	t / not reject	the null hypo	othesis based	on their tes	t stat and	cv oe		
A1 must mention ice cream and sunglasses	(d)	A1 Conclusion	must me	ntion ice cre	am and sung	lasses					
	(u)	A1 must menti	on ice cre	am and sun	glasses						

Question Number	Scheme	Marks	
4 (a)	$X_i$ be rv 'weight of $i^{\text{th}}$ randomly chosen egg'		
	$\mathrm{E}(X_1 - X_2) = 0$	B1	
	$Var(X_1 - X_2) = 2 \times 5^2 = 50$	B1	
	$P( X_1 - X_2  > 2) = 2P(X_1 - X_2 > 2)$	M1	
	$=2P(Z > \frac{2}{2})$	dM1	
	-2P(7 > 0.2828)		
	$= 2\Gamma(Z > 0.2020)$ = 2(1 - 0.6103) - 0.7704 ourt 0.777.0.770	Δ1	
	-2(1-0.0103)-0.7794 awit 0.777-0.779	Π	(5)
(b)	$W = C + V + V + \cdots + V$		(3)
(0)	$W = C + X_1 + X_2 + \dots + X_{12}$ F(W) = 40 + 12 × 60 = 760	R1	
	$L(W) = 40 + 12 \times 60 = 700$ $V_{cer}(W) = 1.5^2 + 12 \times 5^2$	M1	
	$var(w) = 1.5 + 12 \times 5$ = 302.25	A1	
	= 502.25		
	Distribution is $N(760, 302.25)$		(2)
(c)		M1	(3)
(0)	$P(W > 800) = P\left(Z > \frac{800 - 760}{\sqrt{302.25}}\right)$	101 1	
	=1-P(Z < 2.3007)		
	= 0.0107 awrt 0.0107	A1	
			(2)
		Total 10	
Notes (a)	B1 for 0		
	B1 for 50		
	M1 for $ X_1 - X_2  > 2$ seen. Accept $X_1 - X_2 > 2$ provided a subsequent doubling of the		
	probability is seen. i.e. $0.3897 \times 2$ .		
	dM1 standardise with their 0 and their $\sqrt{50}$ dependent on previous M.		
(b)	R1 awit 0.777-0.779		
(0)	M1 requires squares		
	A1 cao		
(c)	Must be finding correct probability (i.e. $P(W > 800)$ or $P(Z > 2.3007)$ etc.) and		
	standardise with 800 and their 760 and their $\sqrt{302.25}$		
	A1 awrt 0.0107 from correct working.		

Question Number	Scheme	Marks
5(a)	$\mathbf{H}_0: \boldsymbol{\mu}_e = \boldsymbol{\mu}_n \ , \ \mathbf{H}_1: \boldsymbol{\mu}_e > \boldsymbol{\mu}_n$	B1
	26.3-24.8 1.5 1.5	
	$z = \frac{1}{\sqrt{12.2 \cdot 10.1}} = \frac{1}{\sqrt{0.58904}} = \frac{1}{0.76749}$	M1M1
	$\sqrt{\frac{35}{42}} + \frac{42}{42}$	
	<i>z</i> =1.9544 awrt 1.95	A1
	Critical value is 1.6449	B1
	Reject $H_0$ . Doctor's claim is supported.	A1
		(6)
(b)	Either assume $\overline{X}$ has a normal distribution (for both samples) or assume sample sizes are	
	large enough to use CLT Assume individual <b>results</b> are independent	
	Assume $\sigma^2 = s^2$ for <b>both</b> populations or a single general population	B1 B1
	Assume 0 = 5 for both populations of a single general population	(2)
(c)	$(35 \times 263 + 317 - 0522)$	(2) B1
(•)	$\overline{x} = \left(\frac{35 \times 20.5 + 51.7}{36} = \frac{952.2}{36}\right) 26.45$	
	Even $n = 35$ $\sum r^2 = 34 \times 12.2 \pm 35 \times 26.3^2 (-24.623.95)$	M1
	$101 \ n = 33, \ \sum x = 54 \times 12.2 + 53 \times 20.3 \ (= 24023.53)$	
	For $n = 36$ , $s^2 = \frac{25628.84 - 36 \times 26.45^2}{12.661} = 12.661$ awrt 12.7	UMTAT
	35	(4)
		(4) Total 12
Notes (a)	Both hyps, one tailed only oe.	
	Accept $\mu_1, \mu_2$ or $\mu_A, \mu_B$ etc if there is some indication of which is which.	
	M1 for correct method for standard error	
	M1 for whole expression	
	Al awrt 1.95 P1 1.6440 or $p = 0.074$ (N0.05)	
	A must mention doctor and claim or description of claim that includes ' <b>mean</b> lung capacity'	
	and 'exercise'.	
ALT (a)	12.2 + 10.1	
	Mi lor $\sqrt{\frac{35}{35} + \frac{42}{42}}$	
	M1 for $1.6449 = \frac{c}{c}$	
	$\frac{12.2 + 10.1}{10.1}$	
	V 35 42	
	A1 for awrt $c = 1.26$ seen	
(a)	B11.5 $\sum_{i=1}^{n} 2^{i}$ of top of $\alpha \in \alpha^{2}$	
(C)	M1 Attempt $\sum_{x} x^2 = 34 \times 12.2 + 35 \times 26.3^2$	
	or $\sum (x-x)^2 = 34 \times 12.2 + 35(26.45 - 26.3)^2 (= 415.5875)$	
	dM1 $s^2 = \frac{\sum x^2 + 31.7^2 - 36 \times 26.45^2}{25}$ or $s^2 = \frac{415.5875 + (31.7 - 26.45)^2}{25}$	
	35 35 35 A1 awrt 12.7	

6(a) H <sub>0</sub> : Binomial with $p = 0.3$ is a good fit. H <sub>1</sub> : Binomial with $p = 0.3$ is not a good fit. $ \frac{0}{0 \text{ beserved } 6} \frac{1}{2 \text{ cor more}} \frac{2 \text{ or more}}{182333784000756+50000781} = 12.005 \text{ or } 12.01 \text{ or } 20.58 = 17.415 \text{ or } 17.41 \text{ or } 17.42 \text{ or } 18.42 \text{ or } 17.42 \text{ or } 10.607 \text{ or } 14.62 \text{ or } 18.42 $	Question Number			Scheme					Marks	8
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	6(a)	H <sub>0</sub> : Binomi	al with $p = 0$ .	3 is a good fi	t. H <sub>1</sub> : Binom	ial wit	th $p = 0.3$ is not	ot a good fit.	B1	
$\begin{bmatrix} \frac{Observed}{Expected} & \frac{6}{50x0.2401} & \frac{25}{50x0.2401} & \frac{19}{50x0.4116} & \frac{10}{50x0.0756+50x0.0081} \\ = 13.23+3.78+0.405 \\ = 17.415 \text{ or } 17.41 \text{ or } 17.42 & \frac{10}{12.20} & \frac{12.00}{E} & \frac{12.00}{E} & \frac{10.949291}{2} & 0.144256 \\ \hline \frac{10}{E} & \frac{1}{2} & 2.998751 & 30.36629 & 20.272926 & 0.2729$			0		1		2 or mo	ore		
$\begin{bmatrix} Fxpected & 50x0.2401 & 50x0.416 & 50x0.256+50x0.0081 \\ = 12.005 or 12.00 & = 20.58 & = 13.23+3.78+0.405 \\ = 17.215 \text{ or } 17.41 \text{ or } 17.42 \\ \hline \frac{0^2}{E} & 3.003751 & 0.949291 & 0.144256 \\ \hline \frac{0^2}{E} & 2.998751 & 30.36929 & 20.72926 \\ \hline \frac{0^2}{E} & 2.998751 & 30.36929 & 20.72926 \\ \hline \frac{0^2}{E} & 2.998751 & 30.36929 & 20.72926 \\ \hline \frac{0^2}{E} & 2.998751 & 30.36929 & 20.72926 \\ \hline \frac{0^2}{E} & 2.998751 & 30.36929 & 20.72926 \\ \hline \frac{0^2}{E} & 2.998751 & 30.36929 & 20.72926 \\ \hline \frac{0^2}{E} & 2.998751 & 30.36929 & 20.72926 \\ \hline \frac{0^2}{E} & 2.998751 & 2.6097 50 = 4.097 & awrt 4.09-4.1(0) \\ M1A1 & V = 3 - 1 = 2 & 3 & 407 \\ \hline \frac{0^2}{E^2} & 2.9987 & (x + 10.0) \\ \hline \text{Binomial with } p = 0.3 \text{ is a good fit.} \\ \hline \frac{1}{R} & \frac{40+62+54+24}{100} = 1.8 & \text{B1 cao} \\ r = 26.78 & 16.07 & 10.87 \\ \hline \frac{1}{R} & \frac{1}{100} & \frac{1}{22.375} & \frac{3}{26.78} & \frac{1}{16.07} & \frac{1}{10.87} \\ \hline \frac{1}{16.07} & \frac{1}{10.53^2} = 2.182 \\ \hline \frac{0^2}{E} & \frac{1}{16.53} = 1.512 & \frac{49}{29.75} = 3.332 & \frac{4.22^2}{26.78} = 0.665 & \frac{1.93^2}{16.07} = 0.232 & \frac{4.87^2}{10.87} = 2.182 \\ \hline \frac{0^2}{E} & \frac{5}{16.53} = 1.512 & \frac{49}{29.75} = 3.378 & \frac{31^2}{26.78} = 3.588 & \frac{18}{16.07} = 0.232 & \frac{4.87^2}{10.87} = 2.182 \\ \hline \frac{0^2}{E} & \frac{5}{16.53} = 1.512 & \frac{49}{29.75} = 3.378 & \frac{31^2}{26.78} = 3.588 & \frac{18}{16.07} = 0.232 & \frac{4.87^2}{10.87} = 2.182 \\ \hline \frac{0^2}{E} & \frac{5}{16.53} = 1.512 & \frac{49}{29.75} = 3.378 & \frac{31^2}{26.78} = 3.588 & \frac{18}{16.07} = 0.232 & \frac{4.87^2}{10.87} = 3.312 \\ \hline \sum \frac{(O-E)^2}{E} = 14.65 - 14.66 \text{ or } \sum \frac{O^2}{E} - N = 114.65 - 100 = 14.65 - 14.66 \\ V = 5 - 1 - 1 = 3 \\ Z_3^2(1\%) = 11.345 (<14.65) \\ Sufficient evidence to reject H_0 \\ Poisson is not a good fit. \\ \hline \text{Notes (a)} \\ \text{B1 both including } p = 0.3 \\ \text{M1 with some combined columns and at least one E correct to 2sf \\ \text{A1 la correct to 2dp and total of expected values is 50. \\ \text{dM1 either method} \\ A1 avrt 4.09-4.1(0) \\ \text{B1 ft there is 0.100000000000000000000000000000000000$		Observed	6		25		19			
$\begin{bmatrix} \frac{1}{2} $		Expected	50x0.	2401	50x0.4116	50x0	0.2646+50x0.07	56+50x0.0081	M1A1	
$\frac{ \frac{ 0-E_{1}^{2} }{E} }{ \frac{ 0-E_{1}^{2} }{E} } = 4.097 \text{ or } \sum \frac{O^{2}}{E} - N = 54.097 50 = 4.097 \text{ awrt } 4.09.4.1(0) \\ \sum \frac{(O-E_{1})^{2}}{E} = 4.097 \text{ or } \sum \frac{O^{2}}{E} - N = 54.097 50 = 4.097 \text{ awrt } 4.09.4.1(0) \\ V = 3 - 1 = 2 \\ \chi_{2}^{2}(5\%) = 5.991 (> 4.1(0)) \\ \text{Insufficient evidence to reject H_{0} (Accept H_{0}) \\ \text{Binomial with } p = 0.3 \text{ is a good fit.} \\ (b) \qquad \overline{x} = \frac{40 + 62 + 54 + 24}{100} = 1.8 \\ r = 26.78 \\ s = 16.07 \\ (c) \qquad H_{0}: \text{Poisson is a good fit. H_{1}: Poisson is not a good fit.} \\ (c) \qquad H_{0}: \text{Poisson is a good fit. H_{1}: Poisson is not a good fit.} \\ \hline \frac{\overline{Dberved} 5 + 40}{100} = 1.8 \\ r = 26.78 \\ s = 16.07 \\ (c) \qquad H_{0}: \frac{Poisson is a good fit. H_{1}: Poisson is not a good fit.} \\ \hline \frac{\overline{Dberved} 5 + 40}{10.53} = 20.75 + 26.78 + 16.07 \\ (D - E_{1})^{2} + \frac{1133^{2}}{16.53} = 4.042} + \frac{10.25^{2}}{10.25^{2}} = 3.532 + \frac{4.22}{26.78} = 0.665 + \frac{150^{2}}{16.07} = 0.232 + \frac{4.87^{2}}{10.87} = 2.18 \\ \hline \frac{O^{2}}{E} + \frac{S^{2}}{16.53} = 1.54.66 \text{ or } \sum \frac{O^{2}}{E} - N = 114.65 - 100 = 14.65 - 14.66 \\ V = 5 - 1 - 1 = 3 \\ \chi_{1}^{2}(1\%) = 11.345 (<14.65) \\ \text{Sufficient evidence to reject H_{0} \\ \text{Poisson is not a good fit.} \\ \text{Notes (a)} \\ \text{B1 both including } p = 0.3 \\ M1 with some combined columns and at least one E correct to 2sf \\ A1 all correct to 2dp and total of expected values is 50. \\ \text{M1 with some combined columns and at least one E correct to 2sf \\ A1 all correct to 2dp and total of expected values is 50. \\ \text{M1 with some combined columns and at least one E correct to 2sf \\ A1 all correct to 2dp and total of expected values is 50. \\ \text{M1 with some combined columns and at least one E correct to 2sf \\ A1 all correct to 2dp and total of expected values is 50. \\ \text{M1 with some combined columns and at least one E correct to 2sf \\ A1 all correct to 2dp and total of expected values is 50. \\ \text{M1 with some combined columns and at least one E correct to 2sf \\ A1 all correct to 2dp and total of expected values is 50. \\ \text{M1 with so$			=12.005 of 12	r 12.01 or	=20.58		=13.23+3.78 -17.415  or  17.4	6+0.405	MIAI	
		$(O - E)^2$	12.				-17.415 01 17.4			
$\begin{bmatrix} \frac{1}{2E} & 2.998751 & 30.36929 & 20.72926 \\ \sum \frac{(O-E)^2}{E} = 4.097 \text{ or } \sum \frac{O^2}{E} - N = 54.09750 = 4.097 \text{ awrt } 4.09-4.1(0) \\ \text{M1A1} \\ \text{W} = 3-1=2 \\ \chi_2^2(5\%) = 5.991 (> 4.1(0)) \\ \text{Insufficient evidence to reject H0 (Accept H0.) \\ \text{Binomial with } p = 0.3 \text{ is a good fit.} \\ \text{B} \\ \text{Iff} \\ \text{BInomial with } p = 0.3 \text{ is a good fit.} \\ \text{(b)} \\ \overline{x} = \frac{40+62+54+24}{100} = 1.8 \\ r = 26.78 \\ s = 16.07 \\ \text{(c)} \\ \text{H}_0 : \text{Poisson is a good fit. H_1 : Poisson is not a good fit.} \\ \hline \\ \frac{10}{2E} \frac{0}{16.53} = \frac{10.27}{29.75} = 26.78 \\ \frac{10.2}{29.75} = 26.78 \\ \frac{10.2}{29.75} = 0.655 \\ \frac{1.93}{16.07} = 0.232 \\ \frac{4.87}{10.87} = 2.182 \\ \frac{O^2}{E} = \frac{14.65-14.66 \text{ or } \sum \frac{O^2}{E} - N = 114.65-100 = 14.65-14.66 \\ \frac{V = 5-1-1=3}{\chi_3^2(1\%) = 11.345} (< 14.65) \\ \text{Sufficient evidence to reject H0 \\ Poisson is not a good fit. \\ \hline \\ \text{Notes (a)} \\ \text{B1 both including } p = 0.3 \\ \text{M IA1 all correct to 22p and total of expected values is 50. \\ \text{M1} all correct to 22p and total of expected values is 50. \\ \text{M1} with some combined columns and at least one E correct to 2sf A1 all correct to 22p and total of expected values is 50. \\ \text{M1} all correct to 22p and total of expected values is 50. \\ \text{M1} all correct to 22p and total of expected values is 50. \\ \text{M1} \text{ with some combined columns and at least one E correct to 2sf A1 all correct to 22p and total of expected values is 50. \\ \text{M1} \text{ with some combined columns and at least one E correct to 2sf A1 all correct to 22p and total of expected values is 50. \\ \text{M1} \text{ with some combined columns and at least one E correct to 2sf A1 all correct to 22p and total of expected values is 50. \\ \text{M1} \text{ with some combined columns and at least one E correct to 2sf A1 all correct to 24p and total of expected values is 50. \\ \text{M1} \text{ with some combined columns and at least one E correct to 2sf A1 all correct to 24p and total of expected values is 50. \\ \text{M1} \text{ with some combined columns -1} \\ \text{B1} \text{ thereic}  with some com$		E		3.003751	0.949291			0.144256		
$\sum_{k=1}^{10} \frac{(O-E)^2}{E} = 4.097 \text{ or } \sum_{k=1}^{10} - N = 54.097 50 = 4.097 \text{ awrt } 4.09-4.1(0) \text{ MIAI}$ $V = 3-1=2$ $\chi_2^3(5\%) = 5.991 (> 4.1(0))$ Insufficient evidence to reject H <sub>0</sub> (Accept H <sub>0</sub> ) Binomial with $p = 0.3$ is a good fit. (b) $\overline{x} = \frac{40+62+54+24}{100} = 1.8$ $r = 26.78$ $s = 16.07$ (c) H <sub>0</sub> : Poisson is a good fit. H <sub>1</sub> : Poisson is not a good fit. $\frac{\overline{0} + 62 + 54 + 24}{100} = 1.8$ $r = 26.78$ $s = 16.07$ (d) $\frac{1}{2} = \frac{2}{3} + \frac{3}{20.75} + \frac{3}{26.78} + \frac{1}{16.07} + \frac{3}{10.87} + 2.182}{\frac{10.25}{16.07} + 2.53} + \frac{4.22^2}{26.78} + 0.665 + \frac{1.93^2}{16.07} + 0.232 + \frac{4.87^2}{10.87} + 2.182}$ $\sum_{k=1}^{10} \frac{(O-E)^2}{E} = 14.65 - 14.66 \text{ or } \sum_{k=1}^{10} - N = 114.65 - 100 = 14.65 - 14.66$ $V = 5 - 1 - 1 = 3$ $\chi_2^3(1\%) = 11.345 (< 14.65)$ Sufficient evidence to reject H <sub>0</sub> Poisson is not a good fit. Notes (a) B1 both including $p = 0.3$ M1 with some combined columns and at least one <i>E</i> correct to 2sf A1 all correct to 2dp and total of expected values is 50. dM1 either method A1 avrat 4.09-4.1(0) B1 ft their columns -1 B1 to their columns -1		$\frac{B}{E}$		2.998751	30.36929			20.72926		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		$\sum \frac{(O-E)^2}{E}$	= 4.097 or	$\sum \frac{O^2}{E} - N =$	= 54.097 – 5	0 = 4.	097	awrt 4.09-4.1(0)	dM1A1	
$\begin{array}{c c} \chi_2^2(5\%) = 5.991 \ (> 4.1(0)) \\ \text{Insufficient evidence to reject } H_0 \ (\text{Accept } H_0 \ ) \\ \text{Binomial with } p = 0.3 \ \text{is a good fit.} \\ \hline \\ \text{Binomial with } p = 0.3 \ \text{is a good fit.} \\ \hline \\ \pi = \frac{40 + 62 + 54 + 24}{100} = 1.8 \\ r = 26.78 \\ s = 16.07 \\ \hline \\ \text{(c)} \\ \text{H}_0 : \text{Poisson is a good fit. } H_1 : \text{Poisson is not a good fit.} \\ \hline \\ \hline \\ \hline \\ \frac{10}{\text{Observed}} = \frac{0}{5} & \frac{1}{40} & \frac{2}{31} & \frac{3}{18} & \frac{4 \text{ or more}}{10.07} \\ \hline \\ \hline \\ \hline \\ \hline \\ \frac{11.53^2}{E} = 8.042. & \frac{10.25^2}{29.75} - \frac{3.532.}{26.78} & \frac{4.22^2}{16.07} = 0.232. & \frac{4.87^2}{10.87} = 2.182. \\ \hline \\ $		v = 3 - 1 = 2							B1ft	
$ \begin{array}{c c} \text{Insufficient evidence to reject } H_{0}(\text{Accept } H_{0}) \\ \text{Binomial with } p = 0.3 \text{ is a good fit.} \\ \hline \\ \hline \\ \text{Bi cao} \\ \hline \\ \frac{x}{x} = \frac{40 + 62 + 54 + 24}{100} = 1.8 \\ r = 26.78 \\ s = 16.07 \\ \hline \\ \text{(c)} \\ \hline \\ \text{H}_{0}: \text{Poisson is a good fit. } H_{1}: \text{Poisson is not a good fit.} \\ \hline \\ \frac{\overline{008} + 20}{100} = \frac{1}{100} = \frac{2}{100} = \frac{3}{10} = \frac{4}{100} \text{ or more}}{1} \\ \hline \\ \frac{\overline{008} + 20}{100} = \frac{1}{100} = \frac{1}{100} = \frac{2}{100} = \frac{3}{100} = \frac{4}{100} \text{ or more}}{1} \\ \hline \\ \frac{\overline{008} + 20}{100} = \frac{1}{100} = \frac$		$\chi_2^2(5\%) = 5.$	991 (>4.1(0)	))					B1ft	
Binomial with $p = 0.3$ is a good fit. (b) $\overline{x} = \frac{40 + 62 + 54 + 24}{100} = 1.8$ (8) r = 26.78 (3) r = 26.78 (3) (c) $H_0$ : Poisson is a good fit. $H_1$ : Poisson is not a good fit. $\overline{\frac{0 - E}{E}}$ (1.5.3) (29.75) (26.78) (16.07) (10.87) (15.3) (29.75) (26.78) (16.07) (10.87) (15.3) (29.75) (26.78) (16.07) (10.87) (15.3) (29.75) (29.75) (26.78) (16.07) (10.87) (15.3) (29.75) (29.75) (26.78) (16.07) (10.87) (10.87) (15.3) (29.75) (29.75) (26.78) (16.07) (10.87) (10.87) (15.3) (29.75) (29.75) (26.78) (16.07) (10.87) (10.87) (15.3) (29.75) (29.75) (26.78) (16.07) (10.87) (10.87) (15.3) (29.75) (29.75) (26.78) (16.07) (10.87) (10		Insufficient e	vidence to reje	ct H <sub>0</sub> (Accept	ot $H_0$ )					
(b) $\bar{x} = \frac{40+62+54+24}{100} = 1.8$ r = 26.78 $s = 16.07$ (c) $H_0$ : Poisson is a good fit. $H_1$ : Poisson is not a good fit. $\frac{1}{Expected} \frac{0}{16.53} \frac{1}{29.75} \frac{3}{26.78} \frac{4}{16.07} \frac{1}{10.87} = 2.182}{10.87}$ (3) B1 (3) B1 (3) C) $\frac{1}{12} \frac{11.53^2}{16.53} = 8.042 \frac{10.25^2}{29.75} = 3.532 \frac{4.22^2}{26.78} = 0.665 \frac{1.93^2}{16.07} = 0.232 \frac{4.87^2}{10.87} = 2.182}{10.87}$ (4) $\frac{0^2}{E} \frac{5^4}{16.53} = 1.512 \frac{40^2}{29.75} = 53.782 \frac{31^2}{26.78} = 35.885 \frac{18^2}{16.07} = 20.162 \frac{6^2}{10.87} = 3.312}{10.87}$ (4) $\frac{0^2}{E} \frac{5^4}{16.53} = 1.512 \frac{40^2}{29.75} = 53.782 \frac{31^2}{26.78} = 35.885 \frac{18^2}{16.07} = 20.162 \frac{6^2}{10.87} = 3.312}{10.87}$ (5) $\frac{1}{2} \frac{(0-E)^2}{E} = 14.65 - 14.66 \text{ or } \sum \frac{O^2}{E} - N = 114.65 - 100 = 14.65 - 14.66$ (7) $\frac{1}{15} x^2 (1\%) = 11.345 (< 14.65)$ (7) $\frac{1}{10} x^2 (1\%) = 11.345 (< 14.65)$ (8) $\frac{1}{10} x^2 (1\%) = 11.345 (< 14.65)$ (9) $\frac{1}{10} x^2 (1\%) = 11.345 (< 14.65)$ (9) $\frac{1}{10} x^2 (1\%) = 11.345 (< 14.65)$ (9) $\frac{1}{10} x^2 (1$		Binomial with	h $p = 0.3$ is a	good fit.	0				A1	
(b) $\overline{x} = \frac{40+62+54+24}{100} = 1.8$ r = 26.78 s = 16.07 (c) $H_0$ : Poisson is a good fit. $H_1$ : Poisson is not a good fit. $\frac{\overline{0} \text{ bserved}  5}{16.53}  \frac{10}{29.75}  26.78}  \frac{4}{16.07}  \frac{10.87}{10.87} = 0.232  \frac{4.87^2}{10.87} = 2.182}{10.87} = \frac{10}{10.87} = \frac{5^2}{16.53} = 1.512  \frac{40^2}{29.75} = 3.532  \frac{4.22^2}{26.78} = 0.665  \frac{1.93^2}{16.07} = 0.232  \frac{4.87^2}{10.87} = 2.182}{10.87} = \frac{5^2}{10.87} = 1.4.65 - 14.66 \text{ or } \sum \frac{O^2}{E} - N = 114.65 - 100 = 14.65 - 14.66 \text{ or } \sum \frac{10}{2} = -N = 114.65 - 14.66 \text{ or } \sum \frac{O^2}{E} - N = 114.65 - 100 = 14.65 - 14.66 \text{ or } B1 \text{ cao } B1  cao$				•						(8)
$\sum_{k=0}^{N-1} 100^{-1.13} \text{ for } 100^{-1.13} $	(b)	$\overline{r} = \frac{40+62}{7}$	+54+24 - 1	8					B1 cao	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		<i>x</i> – 10	00	0						
(c) $H_{0}: Poisson is a good fit. H_{1}: Poisson is not a good fit. M_{1}: Poisson is not a good fit. Poisson is poi$		r = 26.78							B1 cao	
(c) $H_{0}: Poisson is a good fit. H_{1}: Poisson is not a good fit.  \frac{0}{0} \frac{1}{10} \frac{2}{2} \frac{3}{3} \frac{4 \text{ or more}}{16.07 10.87} \\ \frac{0}{10.87} \frac{0}{10.53} \frac{29.75}{29.75} \frac{26.78}{26.78} \frac{16.07}{16.07} \frac{10.87}{10.87} \\ \frac{0}{E} \frac{11.53^{2}}{16.53} = 8.042. \frac{10.25^{2}}{29.75} = 3.532 \frac{4.22^{2}}{26.78} = 0.665 \frac{1.93^{2}}{16.07} = 0.232 \frac{4.87^{2}}{10.87} = 2.182} \\ \frac{0}{E} \frac{2^{2}}{10} \frac{5^{2}}{16.53} = 1.512 \frac{40^{2}}{29.75} = 53.782 \frac{31^{2}}{26.78} = 35.885 \frac{18^{2}}{16.07} = 2.0162 \frac{6^{2}}{10.87} = 3.312} \\ \frac{10.25^{2}}{E} = 14.65 - 14.66 \text{ or } \sum \frac{0^{2}}{E} - N = 114.65 - 100 = 14.65 - 14.66 \text{ or } B1 \text{ fit or line are to reject } H_{0} \text{ Poisson is not a good fit.} \\ Notes (a) B1 both including p = 0.3 M1 with some combined columns and at least one E correct to 2sf A1 all correct to 2dp and total of expected values is 50. dM1 either method A1 awrt 4.09-4.1(0) B1 fit their columns -1 B1 fit heir reither are the fit with the fit for the fit we fi$		s = 16.07							B1 cao	(2)
$H_{0}: Poisson is a good ni. H_{1}: Poisson is not a good ni. H_{2}: Poisson is not a good ni. H_{3}: Poisson is not a good ni. H_{4}: Poisson is not a good ni. H_$	$(\mathbf{c})$	II . Delegen	is a sold fit	II . Delesen	is not a coord of	C. 4			<b>B</b> 1	(3)
Notes (a) B1 both including $p = 0.3$ M1 with some combined columns and at least one <i>E</i> correct to 2sf A1 ant 4.09-4.1(0) B1 ft their columns -1 B1 ft their columns -1	(0)	$\Pi_0$ . Poisson		$\Pi_1$ . Poisson		III.	2	1	DI	
$\frac{ \frac{1}{2} _{2}}{ \frac{1}{E} _{2}} = \frac{ \frac{1}{1} _{2} _{2}}{ \frac{1}{1} _{2} _{2} _{2}} = \frac{ \frac{1}{1} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2}} = \frac{ \frac{1}{2} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2}} = \frac{ \frac{1}{2} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2}} = \frac{ \frac{1}{2} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2}} = \frac{ \frac{1}{2} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2}} = \frac{ \frac{1}{2} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2} _{2}} = \frac{ \frac{1}{2} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2} _{2}} = \frac{ \frac{1}{2} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2} _{2} _{2}} = \frac{ \frac{1}{2} _{2} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2} _{2} _{2}} = \frac{ \frac{1}{2} _{2} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2} _{2} _{2}} = \frac{ \frac{1}{2} _{2} _{2} _{2}}{ \frac{1}{2} _{2} _{2} _{2} _{2} _{2} _{2} _{2} $		Observed	0 5	40	31		18	4 of more 6		
Notes (a) B1 both including $p = 0.3$ M1A1 B1 both including $p = 0.3$ M1 with some combined columns and at least one <i>E</i> correct to 2sf A1 all correct to 2dp and total of expected values is 50. M1A1 B1 ft their columns -1 B1 ft their columns -1 B1 ft their columns -1 B1 ft their		Expected	16.53	29.75	26.78		16.07	10.87		
$\frac{(O-E)^{2}}{E} = \frac{16.53}{29.75} = 3.532 = \frac{4.22}{26.78} = 0.665 = \frac{16.07}{16.07} = 0.252 = 10.87 = 2.102 = \frac{10.87}{10.87} = 3.512 = \frac{40^{2}}{29.75} = 3.532 = \frac{31^{2}}{26.78} = 35.885 = \frac{18^{2}}{16.07} = 20.162 = \frac{6^{2}}{10.87} = 3.312 = \frac{10.87}{10.87} = 3.312 = \frac{10.87}{10.87} = 3.312 = \frac{10.87}{10.87} = 20.162 = \frac{10.87}{10.87} = 3.312 = \frac{10.87}{10.87} = 3.312 = \frac{10.87}{10.87} = 20.162 = \frac{10.87}{10.87} = 3.312 = \frac{10.87}{10.87} = 20.162 = \frac{10.87}{10.87} = 3.312 =$		$(Q-F)^2$	$\frac{11.53^2}{-8.042}$	10.25 <sup>2</sup>	4 22 <sup>2</sup>		$1.93^2 - 0.232$	$\frac{4.87^2}{-2.182}$		
$\frac{O}{E} = \frac{5^{2}}{16.53} = 1.512 = \frac{40^{2}}{29.75} = 53.782 = \frac{31^{2}}{26.78} = 35.885 = \frac{18^{2}}{16.07} = 20.162 = \frac{6^{3}}{10.87} = 3.312 = \frac{10}{10.87} = 3.312 = \frac{10}{10.87} = 14.65 - 14.66 \text{ or } \sum \frac{O^{2}}{E} - N = 114.65 - 100 = 14.65 - 14.66 \text{ or } B1 \text{ fm} = 113.45 \text{ (<} 14.65\text{ )} = 11.345 \text{ (} 1.63\text{ )} = 11.343 \text{ (} 1.63\text{  )} = 11.343 \text{ (} 1.63\text{ )} = 11.343 \text{ (} 1.63\text{ )} = 11.343 \text{ (} 1.63\text{ )} = 11.343 \text{ (} 1.63\text{ )} = 11.343 \text$		$\frac{(O - L)}{E}$	16.53	$\frac{10.23}{29.75} = 3.532$	$\frac{4.22}{26.78} = 0.6$	65	16.07	10.87 - 2.102		
$\frac{1}{E} = 16.53 = 29.75 = 35.885 = 10.87 = 20.162 = 10.87$ $\sum \frac{(O-E)^2}{E} = 14.65 - 14.66 \text{ or } \sum \frac{O^2}{E} - N = 114.65 - 100 = 14.65 - 14.66$ $V = 5 - 1 - 1 = 3$ $\chi_3^2 (1\%) = 11.345 \ (<14.65)$ Sufficient evidence to reject H <sub>0</sub> Poisson is not a good fit. A1 cao B1 both including $p = 0.3$ M1 with some combined columns and at least one E correct to 2sf A1 all correct to 2dp and total of expected values is 50. dM1 either method A1 awrt 4.09-4.1(0) B1 ft their columns -1 B1 ft their		$O^2$	$\frac{5^2}{}=1.512$	$\frac{40^2}{}=53.782$	2		18 <sup>2</sup>	$\frac{6^2}{3.312}$		
Notes (a) B1 both including $p = 0.3$ M1 with some combined columns and at least one <i>E</i> correct to 2sf A1 all correct to 2dp and total of expected values is 50. dM1 either method A1 awrt 4.09-4.1(0) B1 ft their		$\overline{E}$	16.53	29.75	$\frac{1}{26.78} = 35.$	885	$\frac{10}{16.07} = 20.162$	10.87		
Notes (a) B1 both including $p = 0.3$ M1 with some combined columns and at least one E correct to 2sf A1 all correct to 2dp and total of expected values is 50. dM1 either method A1 awrt 4.09-4.1(0) B1 ft their		$\sum \frac{(O-E)^2}{2}$	=14.65 - 14.	$\overline{66 \text{ or } \Sigma^{O^2}}$	-N = 114.65	-100	= 14.65 - 14.60	6	M1A1	
$V = 5 - 1 - 1 = 3$ B1 cao $\chi_3^2(1\%) = 11.345$ (<14.65)			2	$\sim E$					D1	
$\chi_3^{-}(1\%) = 11.345 \ (< 14.65)$ DiffSufficient evidence to reject $H_0$ A1 caoPoisson is not a good fit.A1 caoNotes (a)B1 both including $p = 0.3$ M1 with some combined columns and at least one $E$ correct to 2sfA1 all correct to 2dp and total of expected values is 50.dM1 either methodA1 awrt 4.09-4.1(0)B1 ft their columns -1B1 ft their		v = 5 - 1 - 1 = 3								
Sufficient evidence to reject $H_0$ A1 caoPoisson is not a good fit.(6)Notes (a)B1 both including $p = 0.3$ M1 with some combined columns and at least one $E$ correct to 2sfA1 all correct to 2dp and total of expected values is 50.dM1 either methodA1 awrt 4.09-4.1(0)B1 ft their columns -1B1 ft their		$\chi_3^2(1\%) = 11$		5)					DIII	
Notes (a) B1 both including $p = 0.3$ M1 with some combined columns and at least one <i>E</i> correct to 2sf A1 all correct to 2dp and total of expected values is 50. dM1 either method A1 awrt 4.09-4.1(0) B1 ft their columns -1 B1 ft their		Sufficient evi Poisson is not	dence to reject t a good fit.	t H <sub>0</sub>					A1 cao	
Notes (a)B1 both including $p = 0.3$ Total 17M1 with some combined columns and at least one $E$ correct to 2sfA1 all correct to 2dp and total of expected values is 50.dM1 either methodA1 awrt 4.09-4.1(0)B1 ft their columns -1B1 ft their columns -1			U							(6)
Notes (a) B1 both including $p = 0.3$ M1 with some combined columns and at least one <i>E</i> correct to 2sf A1 all correct to 2dp and total of expected values is 50. dM1 either method A1 awrt 4.09-4.1(0) B1 ft their columns -1 B1 ft their									Total 17	
M1 with some combined columns and at least one <i>E</i> correct to 2st A1 all correct to 2dp and total of expected values is 50. dM1 either method A1 awrt 4.09-4.1(0) B1 ft their columns -1 B1 ft their	Notes (a)	B1 both inclu	ding $p = 0.3$				•			
dM1 either method A1 awrt 4.09-4.1(0) B1 ft their columns -1 B1 ft their		MI with som	e combined co	lumns and at	least one $E$ co	rrect to	o 2st			
A1 awrt 4.09-4.1(0) B1 ft their columns -1 B1 ft their		dM1 either m	ethod	iai oi expecie	u values is 50.					
B1 ft their columns -1 B1 ft their		A1 awrt 4.09-4.1(0)								
B1 ft their		$ \begin{array}{c} L & L & L & L & L & L & L & L & L & L $								
		B1 ft their								
(c) B1 no parameters included	(c)	A1 cao B1 no narame	eters included							
M1 either method	(~)	M1 either me	thod							

Question			
Number	Scheme	Marks	
7(a)	$19.5 \pm 1.6449 \times \frac{1.5}{5}$	M1P1	
	$\sqrt{50}$ (10.151 10.948)		
	awrt 19.2, awrt 19.8	AIAI	
<i>(</i> <b>1</b> )			(4)
(b)	CI does not contain 20 oe	MI	
	Fast Food restaurant statement is too high; they should reduce the stated value.	A1	
			(2)
(c)	$P( \bar{X} - \mu  < 0.5) = 0.9$		
	$\frac{0.5}{2} = 1.6449$	M1A1	
	$\frac{2}{L}$	MIAI	
	$\sqrt{n}$		
	$n = \left(2 \times \frac{1.0449}{0.5}\right) = 43.29$	dM1A1	
	Sample size required is 44	A1	
			(5)
		Total 11	
Notes			
(a)	M1 correct with their z i.e. $19.5 \pm (z \text{ value}) \times \frac{1.5}{\sqrt{50}}$		
	B1 for 1.6449		
	A1 awrt 19.2, A1 awrt 19.8(5)		
(b)	M1 Require 20 compared to their interval		
	A1 Accept statement that relates to 20 being above the interval.		
(c)	M1 $\frac{0.5}{2} = z$ value or equivalent expression		
	$\overline{\sqrt{n}}$		
	A1 All correct		
	dM1 Attempt to solve $\frac{0.5}{\frac{2}{\sqrt{z}}}$ = their z value		
	$\sqrt{n}$ A1 awrt 43.3		

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