Chi-Squared Tests 2 MS

Q1.

8	H_0: No association *or* method is independent of gender (AEF)	**B1**	State (at least) null hypothesis
	E_i: 9·0 19·8 31·2 6·0 13·2 20·8	**M1 A1**	Find expected values E_i (**A0** if rounded to integers)
	$\chi^2 = 0{\cdot}111 + 3{\cdot}073 + 1{\cdot}482$ $+ 0{\cdot}167 + 4{\cdot}610 + 2{\cdot}223$ (to 2 d.p.) $= 11{\cdot}7$ (*or* 12·3)	**M1 A1**	Find value of χ^2 from $\Sigma (E_i - O_i)^2 / E_i$ [or $\Sigma O_i^2/E_i - n$] (allow 12·3 if integer values of E_i used)
	$\chi_{2,\,0.99}^{\,2} = 9{\cdot}21$	**B1**	State or use correct tabular χ^2 value
	Reject H_0 if χ^2 > tabular value (AEF)	**M1**	Valid method for reaching conclusion
	11·7 [± 0·1] > 9·21 so there is an association	**A1**	Correct conclusion, from correct values
		8	

Q2.

8	H_0: Colour is independent of type *or* no association between colour and type (AEF)	**B1**	State (at least) null hypothesis in full
	E_i: 47·67 43·33 39 36·67 33·33 30 25·67 23·33 21 (to 3 s.f.)	**M1 A1**	Find expected values E_i (A0 if rounded to integers)
	$X^2 = 0{\cdot}597 + 1{\cdot}241 + 0{\cdot}103$ $+ 1{\cdot}603 + 1{\cdot}333 + 0{\cdot}033$ $+ 0{\cdot}212 + 0{\cdot}019 + 0{\cdot}429 = 5{\cdot}57$ (to 3 s.f.)	**M1 A1**	Find value of χ^2 from $\Sigma (E_i - O_i)^2 / E_i$ [or $\Sigma O_i^2 / E_i - n$] (allow 5·64 for this A1 if integer values of E_i used)
	$\chi_{4,\,0.9}^{\,2} = 7{\cdot}779$ *or* 7·78	**B1**	State or use correct tabular χ^2 value
	Accept H_0 if X^2 < tabular value (AEF)	**M1**	Valid method for reaching conclusion
	5·57 [± 0·01] < 7·78 so independent *or* no association (AEF)	**A1**	Correct (abbreviated) conclusion, from approx. correct values
		8	

Q3.

8	H_0: Holidays are independent of salesman *or* no association between holidays and salesman (AEF)	**B1**	State (at least) null hypothesis Find expected values (lose A1 if rounded to integers) Find value of X^2 from $\Sigma (E_i - O_i)^2 / E_i$ [or $\Sigma O_i^2/E_i - n$] State or use correct tabular χ^2 value
	E_i: 29·68 33·04 21·28 23·32 25·96 16·72 (to 1 d.p.)	**M1 A1**	
	X^2 = 0·7380 + 0·7446 + 0·0037 + 0·9392 + 0·9477 + 0·0047	**M1**	
	= 3·38 (to 3 s.f.)	**A1**	
	$\chi_{2,\,0.9}^{\,2}$ = 4·605 (to 3 s.f.)	**B1**	
	Accept H_0 if X^2 < tabular value	**M1**	Compare their calculated value with their X^2 value and appropriate conclusion
	Type of holidays is independent of salesman (AEF)	**A1**	Correct conclusion, from correct values $(3.37 - 3.39)$
		8	

Chi-Squared Tests 2 MS

Q4.

1	<table><tr><td>49 E = 56.8</td><td>51 E = 47.6</td><td>40 E = 35.6</td></tr><tr><td>93 E = 85.2</td><td>68 E = 71.4</td><td>49 E = 53.4</td></tr></table>	**M1A1**
	$\frac{(49-56.8)^2}{56.8}+\frac{(51-47.6)^2}{47.6}+\frac{(40-35.6)^2}{35.6}+\frac{(93-85.2)^2}{85.2}+\frac{(68-71.4)^2}{71.4}+\frac{(49-53.4)^2}{53.4}$	**M1**
	= 3.096 (3.10)	**A1**
	Use appropriate tabular value = 4.605	**M1**
	3.096 < 4.605 so the grades awarded are independent of the background	**A1**
		6

Q5.

8	Find expected values (to 1 d.p.):	24·48 30·72 16·8			
	(lose A1 if rounded to integers)	48·96 61·44 33·6			
		28·56 35·84 19·6	M1 A1		
	State (at least) null hypothesis (A.E.F.):	H_0: Grade independent of town	B1		
	Calculate value of χ^2 to 1 d.p.:	χ^2 = 0·009 + 0·350 + 0·467			
		+ 1·669 + 0·034 + 1·719			
		+ 2·567 + 0·094 + 5·518			
		= 12·4[3]	M1 A1		
	Compare with consistent tabular value (to 1 d.p.):	$\chi_{4,\,0.975}^{\,2}$ = 11·1[4]	B1		
	Conclusion consistent with values (A.E.F):	Grade not independent of town	A1 √	7	
	State town with max. contribn. (√ on exp. values):	Town *C*	B1 √		
	State valid comment (√ on exp. values), e.g.:	Signal poorer than expected in *C*	B1 √	2	**[9]**