Stats 2 Chi-Squared Contingency Table Tests Questions

2 Year 12 students at Newstatus School choose to participate in one of four sports during the Spring term.

The students' choices are summarised in the table.

	Squash	Badminton	Archery	Hockey	Total
Male	5	16	30	19	70
Female	4	20	33	53	110
Total	9	36	63	72	180

(a) Use a χ^2 test, at the 5% level of significance, to determine whether the choice of sport is independent of gender. *(10 marks)*

(b) Interpret your result in part (a) as it relates to students choosing hockey. *(2 marks)*

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4 It is claimed that the area within which a school is situated affects the age profile of the staff employed at that school. In order to investigate this claim, the age profiles of staff employed at two schools with similar academic achievements are compared.

Academia High School, situated in a rural community, employs 120 staff whilst Best Manor Grammar School, situated in an inner-city community, employs 80 staff.

The **percentage** of staff within each age group, for each school, is given in the table.

Age	Academia High School	Best Manor Grammar School
22–34	17.5	40.0
35–39	60.0	45.0
40–59	22.5	15.0

(a) (i) Form the data into a contingency table suitable for analysis using a χ^2 distribution. *(2 marks)*

(ii) Use a χ^2 test, at the 1% level of significance, to determine whether there is an association between the age profile of the staff employed and the area within which the school is situated. *(9 marks)*

(b) Interpret your result in part (a)(ii) as it relates to the 22–34 age group. *(2 marks)*

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7 A statistics unit is required to determine whether or not there is an association between students' performances in mathematics at Key Stage 3 and at GCE.

A survey of the results of 500 students showed the following information:

		GCE Grade				
		A	B	C	Below C	Total
Key Stage 3 Level	8	60	55	47	43	205
	7	55	32	31	26	144
	6	40	38	35	38	151
	Total	155	125	113	107	500

(a) Use a χ^2 test at the 10% level of significance to determine whether there is an association between students' performances in mathematics at Key Stage 3 and at GCE.
(9 marks)

(b) Comment on the number of students who gained a grade A at GCE having gained a level 7 at Key Stage 3.
(1 mark)

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1 Two groups of patients, suffering from the same medical condition, took part in a clinical trial of a new drug. One of the groups was given the drug whilst the other group was given a placebo, a drug that has no physical effect on their medical condition.

The table shows the number of patients in each group and whether or not their condition improved.

	Placebo	Drug
Condition improved	20	46
Condition did not improve	55	29

Conduct a χ^2 test, at the 5% level of significance, to determine whether the condition of the patients at the conclusion of the trial is associated with the treatment that they were given.
(10 marks)

Stats 2 Chi-Squared Contingency Table Tests Answers

2(a)	H_o : Choice independent of gender	B1		gender not associated with choice

	Squash	Badminton	Archery	Hockey		
Male	5/3.5	16/14	30/24.5	19/28	M1	
Female	4/5.5	20/22	33/38.5	53/44		

Combine Squash and Badminton — M1 — $E_i < 5$ (Similar categories)

	S & B	Archery	Hockey		
Male	21/17.5	30/24.5	19/28	M1	
Female	24/27.5	33/38.5	53/44	M1	

χ^2 values

	S & B	Archery	Hockey		
Male	0.7000	1.2347	2.8928	M1	
Female	0.4455	0.7857	1.8409		

$\chi^2_{calc} = 7.90$	A1		(7.8 to 7.9)
$v = 2$	B1		
$\chi^2_{5\%}(2) = 5.991$	B1ft		(on their v)
Reject H_o Sufficient evidence, at the 1% level of significance, to support an association between the choice of sport and gender	A1ft	10	reject H_o and H_o stated **or** statement in context
(b) **More females and fewer males** chose to participate in hockey **than expected**	B1 B1	2	
Total		**12**	

4(a)(i)								

	A	B	Total
22-34	21	32	53
35-39	72	36	108
40-59	27	12	39
Total	120	80	200

B1 — for A values
B1 — 2 — for B values

(ii)

H_0 : no association between area and age profile

H_1 : association between area and age profile

B1 — At least H_0

O_i	E_i	$\dfrac{(O_i - E_i)^2}{E_i}$
24	31.8	3.6679
72	64.8	0.8000
24	23.4	0.5538
32	21.2	5.5019
36	43.2	1.2000
12	15.6	0.8308
$\sum O_i = 200$	$\sum E_i = 200$	$\chi^2 = 12.554$

M1 — Attempt at Row & Column totals
M1 — Attempt at E_i
M1 — Attempt at $\dfrac{(O_i - E_i)^2}{E_i}$
M1 — Attempt at χ^2
A1 — AWFW 12.5 to 12.6 provided correct method used

$v = (3-1)(2-1) = 2$

B1

$\chi^2_{1\%}(2) = 9.210 < 12.554$

B1✓ — ft on their v and χ^2

Reject H_0

The evidence suggests that the area within which a school is situated seems to have an effect on the age-profile of the staff employed.

E1✓ — 9 — ft on χ^2 and calculated value depends on H_0 correct, if stated

(b) There seems to be fewer staff employed in 22 - 34 age group than expected in school A

E1

and more than expected in school B

E1 — 2

		Total		13	

7(a) H_0 : No association between the performances at KS3 and GCE — B1

O_i	E_i	$O_i - E_i$	X^2
60	63.55	−3.55	0.1983
55	44.64	10.36	2.4043
40	46.81	−6.81	0.9907
55	51.25	3.75	0.2744
32	36.00	−4.00	0.4444
38	37.75	0.25	0.0017
47	46.33	0.67	0.0097
31	32.54	−1.54	0.0733
35	34.13	0.87	0.0222
43	43.87	−0.87	0.0173
26	30.82	−4.82	0.7527
38	32.31	5.69	1.0005

M1 — E_i

M1 — $O_i - E_i$

M1 — $(O_i - E_i)^2 / E_i$

M1 — Σ

$X^2 = 6.1897$ — A1 — AWFW 6.05 – 6.35

$v = 3 \times 2 = 6 \quad \Rightarrow \quad \chi^2_{90\%} = 10.645$ — B1B1√ — on their v

Do not reject H_0

No evidence to suggest an association between KS3 results and GCE grades at 10% level of significance. — E1√ — 9

(b) More of the students achieving level 7 at KS3 gain grade A's at GCE than expected. — E1 — 1

| | **Total** | | **10** |

1 H_0: condition independent of treatment
H_1: condition dependent upon treatment — B1

Totals: 66, 84, 75, 75 — B1

O	E	$|O-E|-0.5$	$\dfrac{(|O-E|-0.5)^2}{E}$
20	33	12.5	4.7348
55	42		3.7202
46	33		4.7348
29	42		3.7202

M1A1 — for E_i attempted, correctly

M1 — for use of Yates' correction

M1 — final column

$\chi^2 = 16.91$ — A1

allow 16.9
If no Yates' correction:
possible M1A1M0M1A0
If 0.5 incorrectly used:
possible M1A1M1M1A0

$\chi^2_{5\%}(1) = 3.841 < 16.91$ — B1✓

for χ^2 on their v

Reject H_0 — A1✓

iff H_0 stated correctly
dependent on third M1

Evidence to suggest that the condition of the patients may be dependent upon the treatment that they received — E1✓ — 10

| | Total | | 10 | |