1. The eye colour and gender of 500 students are noted and the results are indicated in the table below.

	Blue	Brown	Green
Male	18	152	50
Female	40	180	60

It is believed that eye colour is related to gender in a school in Banff. It is decided to test this hypothesis by using a χ^2 test at the 5% level of significance.

(a) Write down the null hypothesis for this experiment.

(1)

(b) Show that the number of degrees of freedom is 2.

(1)

(c) Write down the χ^2 critical value for the degrees of freedom.

(1)

(d) Calculate the χ^2 test statistic for this data.

(2)

(e) Does the evidence suggest that eye colour is related to gender in this school? Give a clear reason for your answer.

(2)

(Total 7 marks)

2. Tom performs a chi-squared test to see if there is any association between the time to prepare for a penalty kick (short time, medium time and long time) and the outcome (scores a goal, doesn't score a goal). Tom performs this test at the 10% level.

(a) Write down the null hypothesis.

(b) Find the number of degrees of freedom for this test.

(c) The *p*-value for this test is 0.073. What conclusion can Tom make? Justify your answer.

(Total 6 marks)

3. The local park is used for walking dogs. The sizes of the dogs are observed at different times of the day. The table below shows the numbers of dogs present, classified by size, at three different times last Sunday.

	Small	Medium	Large
Morning	9	18	2
Afternoon	11	6	13
Evening	7	8	9

(a) Write a suitable null hypothesis for a χ^2 test on this data.

(b) Write down the value of χ^2 for this data.

(c) The number of degrees of freedom is 4. Show how this value is calculated.

The critical value, at the 5% level of significance, is 9.488.

(d) What conclusion can be drawn from this test? Give a reason for your answer.

Working:

Answers:

(a) .....

(b) .....

(c) .....

.....

(d) .....

.....

.....

.....

(Total 6 marks)

4. 200 people of different ages were asked to choose their favourite type of music from the choices Popular, Country and Western and Heavy Metal. The results are shown in the table below.

Age/Music choice	**Popular**	**Country and Western**	**Heavy Metal**	**Totals**
11–25	35	5	50	90
26–40	30	10	20	60
41–60	20	25	5	50
Totals	85	40	75	200

It was decided to perform a chi-squared test for independence at the 5% level on the data.

(a) Write down the null hypothesis.

(1)

(b) Write down the number of degrees of freedom.

(1)

(c) Write down the chi-squared value.

(2)

(d) State whether or not you will reject the null hypothesis, giving a clear reason for your answer.

(2)

Working:

Answers:

(a) .....

.....

.....

.....

(b) .....

(c) .....

(d) .....

(Total 6 marks)

1. (a) Eye colour and gender are independent.

OR

There is no relationship (association) between eye colour and gender. (A1) 1

(b) $(2 - 1)(3 - 1)$ (M1)
$= 2$ (AG) 1

(c) 5.991 (5.99) (A1) 1

(d) 4.48 (G2) 2

(e) For comparing χ^2 test statistic with χ^2 critical value (A1)
No, eye colour is not related to gender
χ^2 test statistic < χ^2 critical value (R1)

OR

For comparing their *p*-value with 0.05
No, eye colour is not related to gender (A1)
p-value of 0.106 > 0.05 (R1) 2
[7]

2. (a) Time to prepare is independent of outcome, or, there is no association between time to prepare and the outcome (A1) (C1)

(b) 2 (A1) (C1)

(c) 0.073 < 0.10 For comparing 0.073 with 0.10 or 10% (M1)
For < or saying "less than" (M1)
Reject H_0 (A1)
Time and outcome are not independent of each other or equivalent in words relating to the question (A1) (C4)
[6]

3. (a) H_o: The size of dog is independent of the time of day, (or equivalent) (A1) (C1)
Note: *Award* (A0) *for 'no correlation'*

(b) $\chi^2 = 4.33$. *(accept 4.328)* (M1)(A1) (C2)

Note: *GDC use is anticipated but candidates might calculate this by hand. (M1) can be awarded for a reasonable attempt to use the formula.*

(c) $(3–1)(3–1) = 4$ (A1) (C1)

Note: *Award mark for left hand side seen.*

(d) The hypothesis should not be rejected, *(allow 'accept H_o')*

OR

The size of dog is independent of the time of day (A1)(ft)

$4.33 < 9.488$ or $0.363 > 0.05$ (R1)(ft) (C2)

Notes: *Allow $\chi^2_{calc} < \chi^2_{crit}$ only if a value for χ^2_{calc} is seen somewhere.*

Award (R1)(ft) for comparing the values and (A1)*(ft) if the conclusion is valid according to the comparison given. If no reason is given, or if the reason is wrong* ***both*** *marks are lost. Note that* (A0)*(R1)(ft) can be awarded but* (A1)*(R0) cannot.*

[6]

4. (a) Choice of music is independent of age. (A1) (C1)

(b) $(3 – 1)(3 – 1)$

$= 4$ (A1) (C1)

(c) $\chi^2 = 51.6$ (A2)

Note: *52 is an accuracy penalty (A1)(A0)(AP).* (C2)

(d) *p*-value < 0.05 for 5% level of significance (R1)(ft)

or $51.6 > \chi^2_{crit}$ (R1)(ft)

Reject the null hypothesis *(do not accept the null hypothesis).* (A1)(ft)

Note: *Do not award (R0)(A1).* (C2)

[6]