Chi Sq MS

0 min

0 marks

1. (a) $\dfrac{40}{120}\left(\dfrac{1}{3}, 0.333, 33.3\%\right)$ (A1)(A1)(G2)

         Note: Award (A1) for numerator, (A1) for denominator.

(b) $\dfrac{34}{120}\left(\dfrac{17}{60}, 0.283, 28.3\%\right)$ (A1)(A1)(G2)

         Note: Award (A1) for numerator, (A1) for denominator.

(c) $\dfrac{8}{28}\left(\dfrac{2}{7}, 0.286, 28.6\%\right)$ (A1)(A1)(G2)

         Note: Award (A1) for numerator, (A1) for denominator.

(d) customer satisfaction is **independent** of café   (A1)

         *Note: Accept "customer satisfaction is **not associated with** the café".*

(e) 2   (A1)

(f) 0.754   (G2)

         Note: Award (G1)(G1)(AP) for 0.75 or for correct answer incorrectly rounded to 3 s.f. or more, (G0) for 0.7.

(g)   since $\chi^2_{calc} < \chi^2_{crit}$ (5.991) accept (or Do not reject) H_0 (R1)(A1)(ft)

          Note: Follow through from their value in (e).

      OR

      Accept (or Do not reject) H_0 as p-value (0.686) > 0.05   (R1)(A1)(ft)

          Notes: Do not award (A1)(R0).
          Award the (R1) for comparison of appropriate values.

                                                                                          [12]

2. (a) H_0 : Choice of language is independent of gender.   (A1)

          Notes: Do not accept "not related" or "not correlated".

      (b)   2   (A1)

      (c) $\dfrac{50 \times 69}{150} = 23$ (M1)(A1)(G2)

          *Notes: Award (M1) for correct substituted formula, (A1) for
          23.*

      (d) $\chi^2 = 4.77$ (G2)

          *Notes: If answer is incorrect, award (M1) for correct
          substitution in the correct formula (all terms).*

      (e)   Accept H_0 since
            $\chi^2_{calc} < \chi^2_{crit}$ (5.99) **or** p-value (0.0923) > 0.05   (R1)(A1)(ft)

          Notes: Do not award (R0)(A1).
          Follow through from their (d) and (b).

                                                                                          [8]

3. (a) H_0: The (average) number of meals per day a student has and
            gender are independent   (A1)

          *Note: For "independent" accept "not associated" but do not
          accept "not related" or "not correlated".*

      (b)   2   (A1)

      (c)   5.99 (accept 5.991)   (A1)(ft)

          Note: Follow through from their part (b).

(d) $\dfrac{28 \times 45}{100} = 12.6 = 13$ or $\dfrac{28}{100} \times \dfrac{25}{100} \times 100 = 12.6 = 13$ (M1)(A1)(AG)

> *Notes: Award (M1) for correct formula and (A1) for correct substitution. Unrounded answer must be seen for the (A1) to be awarded.*

(e)   0.0321   (G2)

> *Note: For 0.032 award (G1)(G1)(AP).*
> *For 0.03 with no working award (G0).*

(f) $0.0321 < 5.99$ **or** $0.984 > 0.05$ (R1)
      accept H_0 (A1)(ft)

> *Note: If reason is incorrect both marks are lost, do not award (R0)(A1).*

[9]

4. (a) H_0 : The height of the rice plants is independent of the use of a fertilizer. (A1)

> *Notes: For independent accept "not associated", can accept "the use of a fertilizer has no effect on the height of the plants". Do not accept "not correlated".*

      H_1: The height of the rice plants is not independent (dependent)
      of the use of fertilizer.   (A1)(ft)

> *Note: If H_0 and H_1 are reversed award (A0)(A1)(ft).*

(b) $\dfrac{180 \times 195}{360}$ **or** $\dfrac{180}{360} \times \dfrac{195}{360} \times 360$ (A1)(A1)(M1)

      $= 97.5$ (AG)

> *Notes: Award (A1) for numerator, (A1) for denominator (M1) for division.*
> *If final 97.5 is not seen award at most (A1)(A0)(M1).*

(c) $\chi^2_{calc} = 14.01$ (14.0, 14)   (G2)

      OR

      If worked out by hand award *(M1)* for correct substituted formula
      with correct values, *(A1)* for correct answer.   (M1)(A1)

(d)   2   (A1)

(e) $\chi^2_{crit} = 9.210$ (9.21)   (A1)(ft)

> *Note: (ft) from candidates answer to (d).*

(f)　$\chi^2_{calc} > \chi^2_{crit}$　　　　　　　　　　　　　　　　　　　　　　　(R1)

　　The manufacturer's claim is justified. (or equivalent statement)　　　(A1)

　　　　Note: Do not accept (R0)(A1).

[11]

5.　(a)　28　　　　　　　　　　　　　　　　　　　　　　　　　　　　　(A1)

　(b)　$\dfrac{28\times45}{100}\left(\dfrac{28}{100}\times\dfrac{45}{100}\times100\right)$　　　　　　　　　　　(M1)(A1)(ft)

　　　　Note: Award (M1) for correct formula, (A1) for correct
　　　　substitution.

　　= 12.6　　　　　　　　　　　　　　　　　　　　　　　　　　　(AG)

　　　　Note: Do not award (A1) unless 12.6 seen.

　(c)　(i)　the favourite car colour is **independent** of gender.　　　(A1)

　　　　　Note: Accept there is no association between gender and
　　　　　favourite car colour.
　　　　　Do not accept 'not related' or 'not correlated'.

　　　(ii)　2　　　　　　　　　　　　　　　　　　　　　　　　　　(A1)

　　　(iii)　5.991 (5.99)　　　　　　　　　　　　　　　　　　　(A1)(ft)

　　　　　Note: Follow through from (c)(ii) for their degrees of freedom.
　　　　　Note: Accept any accuracy beyond 3 s.f.

　　　(iv)　Accept the null hypothesis since 1.367 < 5.991　　　(A1)(ft)(R1)

　　　　　Note: Allow "Do not reject". Follow through from their null
　　　　　hypothesis and their critical value.
　　　　　Full credit for use of p-values from GDC [p = 0.505]
　　　　　Do not award (A1)(R0). Award (R1) for valid comparison.

[8]

6.　(a)　(i)　$\dfrac{280}{400}$ $\left(0.7, 70\%\ \text{or equivalent}\right)$　　　　　　　(A1)(A1)(G2)

　　　　　Note: (A1) for correct numerator, (A1) for correct denominator.

　　　(ii)　$\dfrac{57}{210}\left(\dfrac{19}{70}, 0.271, 27.1\%\right)$　　　　　　　　(A1)(A1)(G2)

　　　　　Note: (A1) for correct numerator, (A1) for correct denominator.

(b) $\dfrac{180}{400} \times \dfrac{179}{399}$ (A1)(M1)

> **Note:** *(A1) for correct values seen, (M1) for multiplying their two values (A1) for correct answer.*

$= \dfrac{537}{2660}(= 0.202)$ (A1)(G3)

(c) H_0 : "the preference of brand of cereal is independent of the city".

OR   (A1)

H_0 : "there is no association between the brand of cereal and city".

(d) $df = 2$ (A1)

(e) $\dfrac{210 \times 120}{400}$ (M1)(A1)

> **Note:** *(M1) for substituting in correct formula, (A1) for correct values.*

$= 63$ (AG)

> **Note:** *Final line must be seen or previous (A1) mark is lost.*

(f) 39.3   (G2)

> **Note:** *Award (G1)(A0)(AP) if answers not to 3 s.f.*

(g) $39.3 > \chi^2_{\text{crit}}$ or p-value < 0.05 (R1)(ft)

Do not accept H_0.   (A1)(ft)

> **Notes:** *Allow "Reject H_0" or equivalent.*
> *(ft) from their χ^2 statistic.*
> *Award (R1)(ft) for comparing the appropriate values.*
> *(A1)(ft) can be awarded only if the conclusion is valid according to the comparison given. If no reason given or if reason is wrong both marks are lost. Note that (R1)(A0)(ft) can be awarded but (R0)(A1)(ft) cannot.*

[15]

7. (a) (i) H_0 = wearing of a seat belt and the time a driver has held a licence are independent.   (A1)

> **Note:** *For independent accept "not associated" but do not accept "not related" or "not correlated"*

(ii)   2   (A1)

(iii) $\dfrac{98 \times 45}{200}$ = 22.05 = 22 *(correct to the nearest whole number)*(M1)(A1)(AG)

> *Note: (M1) for correct formula and (A1) for correct substitution. Unrounded answer must be seen for the (A1) to be awarded.*

(iv) $\chi^2 = 8.12$ (G2)

> *Note: For unrounded answer award (G1)(G0)(AP)*
> *If formula used award (M1) for correct substituted formula with correct substitution (6 terms) (A1) for correct answer.*

(v)   "Does not accept H_0"   (A1)(ft)

$\chi^2_{crit} < 8.12$ or p-value < 0.05 (R1)(ft)

> *Note: Allow "Reject H_0" or equivalent. Follow through from their χ^2 statistic. Award (R1)(ft) for comparing the appropriate values. The (A1)(ft) can be awarded only if the conclusion is valid according to the comparison given. If no reason given or if reason is wrong the two marks are lost.*

(b)   (i) $\dfrac{98}{200}$ (= 0.49, 49%)   (A1)(A1)(G2)

> *Note: (A1) for numerator, (A1) for denominator.*

(ii) $\dfrac{15}{45}$ (= 0.333, 33.3%)   (A1)(A1)(G2)

> *Note: (A1) for numerator, (A1) for denominator.*

(c)   (i) $\dfrac{98}{200} \times \dfrac{97}{199}$ = 0.239 (23.9 %)   (A1)(M1)(A1) (G3)

> *Note: (A1) for correct probabilities seen, (M1) for multiplying two probabilities, (A1) for correct answer.*

(ii) $1 - \dfrac{102}{200} \times \dfrac{101}{199} = 0.741$ (74.1 %)   (M1)(M1)

(A1)(ft)(G2)

> *Note: (M1) for showing the product, (M1) for using the*
> *probability of the complement, (A1) for correct answer. Follow*
> *through for consistent use of with replacement.*

OR

$\dfrac{98}{200} \times \dfrac{97}{199} + \dfrac{98}{200} \times \dfrac{102}{199} + \dfrac{102}{200} \times \dfrac{98}{199} = 0.741$ (74.1 %)   (M1)(M1)

(A1)(ft)(G2)

> *Note: (M1) for adding three products of fractions (or*
> *equivalent), (M1) for using the correct fractions, (A1) for*
> *correct answer Follow through for consistent use of with*
> *replacement.*

[18]

8.   (a)

	Drama	Comedy	Film	News
Males	58	119	157	52
Females	86	98	120	61

(M1)(M1)(A1)   3

(b) H_0: favourite TV programme is independent of gender or no association between favourite TV programme and gender

   H_1: favourite TV programme is dependent on gender *(must have both)*   (A1)   1

(c) $\dfrac{365 \times 217}{751}$ (M1)

   $= 105$ (A1)(ft)(G2)   2

(d)   12.6 (accept 12.558)   (G3)   3

(e)   (i)   3   (A1)

   (ii)   7.815 (accept 7.82)((ft) from their (i))   (A1)(ft)

   (iii) *reject H_0 or equivalent statement (eg accept H_1)*   (A1)(ft)   3

[12]

9. (a) (i) H_0 : level of stress is independent of travel time   (A1)

              H_1 : level of stress is not independent of travel time   (A1)(ft)

              (or reasonable equivalents)

      (ii)   12.1 5.24 14.6

              20.1 8.68 24.2

              11.8 5.08 14.2   (M1)(A1)(G2)

> *Note: (M1) for attempting to calculate expected values by*
> *hand eg* $\dfrac{44\times32}{116}=12.1$ *etc.*

                  12 5 15

                  20 9 24

                  12 5 14

              Nearest integers   (A1)(G3)

      (iii) $df = (r-1)\,(c-1) = (3-1)(3-1) = 4$ (M1)(AG)

      (iv) $\chi^2 = 9.83(1)$ (G2)

              OR $\chi^2 = 9.277$ ..... if calculated from integer values   **OR** (M1)(A1)

      (v)   For $\chi^2 = 9.83$ Do not accept H_0 :   (A1)(ft)

              (Level of stress is not independent of travel time or reasonable equivalent)

              because $\chi^2_{calc} > \chi^2_{crit}$ **or** p-value < 0.05 (R1)(ft)

              OR

              For $\chi^2 = 9.278$ Accept H_0 :   (A1)(ft)

              because $\chi^2_{calc} > \chi^2_{crit}$ **or** p-value > 0.05 (R1)(ft)

> *Note: a correct reason must be given for the (A1) to be*
> *awarded.*

   (b)   (i) $r = 0.667$ (A1)

      (ii)   Stress rating increases as travel time increases

             (or reasonable equivalent eg y increases as x increases).   (R1)

> *Note: Do not accept "positive correlation"*

      (iii) $y = 0.181x + 2.22$

              for $0.181x$ and   (A1)

              for 2.22 (A1)

> *Note: For $y = 2.22x + 0.181$, award (A0)(A1)(ft)*

(iv) Putting $x = 45$ (M1)

         $0.181 \times 45 + 2.22$

         $= 10.365$ (10.4)   (A1)(ft)(G2)

           ***Notes:** Allow 10 or 11 only if the method is shown and is correct.*
                    Allow follow through only if method shown.

(v) not reliable …   (A1)

      Because result is outside the data range or because the
      correlation coefficient not high or the sample is small or
      responses are subjective.   (R1)

        Note: *Award (R1) for any of the above. A correct reason must be*
                 given to award the (A1).

                                                                       [18]

10. (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 $< \chi^2$ 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]

11. (a) H_0 : number of entries is independent of gender.   (A1)   1

    (b) 4   (A1)   1

(c)   9.488   (A1)   1

(d) $a = 85$, $b = 29$ (A1)(A1)   2

(e) $\dfrac{(30-32)^2}{32} + ...$ (M1)(A1)

        $= 6.10$ (using given values)   (A1)

        OR

        5.80 (from calculator)   (G3)   3

(f)   Do not reject the null hypothesis as the χ^2 value is less than the critical value.
        So, gender and stroke are independent.   (A1)(R1)   2

        (Also allow "accept").

                                                                                       [10]

12. (a)   (i) $a = 29.45$, $b = -5.55$, $c = 30.8025$, $d = 1.046$ (A4)

                (ii) $\chi^2_{\text{calc}} = 1.012 + 0.946 + 1.118 + 1.046 = 4.12$ (A1)

                (iii)   degrees of freedom $= (2-1)(2-1) = 1$ (A1)

                (iv) $\chi^2_{\text{crit}} = 3.84$ (A1)   7

        (b)   Do not accept H_0. The weight of a puppy is related to the weight
                of the parent.   (A1)(R1)   2
                $\chi^2_{\text{calc}} > \chi^2_{\text{crit}}$

                                                                                       [9]

13. (a) Males $= \dfrac{9000 \times 11000}{20000}$ (M1)(A1)

= 4950 (AG) 2

(b) (i) That gender and grade obtained are independent. (A1)
(There is no connection between gender and grade obtained.)

(ii) $(3 - 1)(2 - 1) = 2$ (A1)

(iii) $\chi^2 = 5.991$ (A1)

(iv) Calculated $\chi^2 = 39.957$
Therefore, reject the Null hypothesis. Gender and grade obtained (R1) 4
are dependent (or there is a connection between gender and grade).

[6]

14. (a) (i) Alternative hypothesis: Choice of candidates depends on
voter location. (A1)

(ii) **a** = 188 (A1)
b = –22 (A1) 3

(b) (i) $\chi^2_{calc} = \dfrac{484}{317} + \dfrac{484}{204} + \dfrac{484}{291} + \dfrac{484}{188}$ (M1)

= 8.14 (accept 8.13) (A1)

Note: Award (G2) for 7.97.

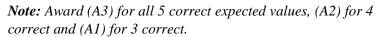(ii) $v = 1$ (A1)

(iii) $\chi^2(0.95, 1)$ (M1)
= 3.84 (A1) 5

(c) (i) Where voters live does affect how they vote. (A1)

(ii) $\chi^2_{calc} > \chi^2$ or $8.14 > 3.84$ so we reject the null hypothesis. (R1) 2

[10]

15. (a)

Colour	%	Expected
Red	35	21
Orange	25	15
Green	20	12
Purple	15	9
Blue	5	3

(A3) 3

*Note: Award (A3) for all 5 correct expected values, (A2) for 4
correct and (A1) for 3 correct.*

(b) Blue   (A1)

It has less than 5 sweets   (R1)   2

(c) H_0 = Colour of sweets is a random sample   (A1)

d.o.f. = $(4-1)(2-1) = 3$ (A1)

critical value = 7.815   (A1)

$$\chi^2 = \frac{(21-18)^2}{21} + \frac{(15-17)^2}{15} + \frac{(12-10)^2}{12} + \frac{(12-15)^2}{12}$$ (M1)

= 1.78   (A1)

1.78 < 7.815   (A1)

Therefore, accept H_0 (A1)   7

[12]

16. (a) (i)   Expected number of male managers

$$= \frac{160}{500} \times \frac{300}{500} \times 500 = \frac{160 \times 300}{500}$$ (M1)(A1)

= 96   (AG)

(ii) $b = 160 - 96 = 64$ (A1)

$c = 300 - 96 - 60 = 144$ (A1)

$d = 240 - 144 = 96$ (A1)   5

(b) (i) H_0: Position is independent of gender   (A1)

(ii) H_1: Position is dependent on gender   (A1)   2

(c) (i) $$\chi^2_{calc} = \frac{(96-95)^2}{96} + \frac{(64-65)^2}{64} + \frac{(114-130)^2}{144} + \frac{(96-110)^2}{96}$$

$$+ \frac{(60-75)^2}{60} + \frac{(40-25)^2}{40}$$ (M1)(A2)

Note: *Award (M1) for using* $\sum \frac{(f_e - f_0)^2}{f_e}$ *, (A2) for all values*

correct.

Special case: Award (A1) if only 1 value is incorrect.

= 12.8   (AG)

(ii)   2 degrees of freedom   (A1)

$\chi^2_{2,0.05} = 5.991$ (A1)

(iii)   Any of: (then reject H_0, accept H_1)   (R1)   6
            Position is dependent on gender.

[13]

17.   (a) $p = 25.2$ $q = 16.8$ $r = 12.4$ (A1)(A1)(A1)   3

      (b)   (i) H_0: There is no connection between gender and subject taken.   (C1)

            (ii)   Degrees of freedom $= (3 - 1)(2 - 1) = 2 \times 1$ (M1)
                    $= 2$ (AG)

            (iii) $\chi^2(2) = 5.99$ (A1)   3

      (c)   Accept H_0 (C1)
           Since $1.78 < 5.99$ (R1)   2

[8]

18.   (a)

	Billiards	Snooker	Darts	Totals
Male Expected	**32.9**	**16.4**	**13.7**	63
Female Expected	**27.1**	**13.6**	**11.3**	52
	60	30	25	115

                                                         (A3)

          ***Note:** Award (A3) for 6 correct expected values (bold), (A2) for 4 correct, (A1) for 2 correct.*

    H_0: Choice of game is independent of gender   (A1)

    H_1: Choice of game is not independent of gender   (A1)

    Degree of freedom: $(3 - 1)(2 - 1) = 2$ (A1)

$$\chi^2 = \sum \frac{(f_0 - f_e)^2}{f_e} = \frac{(39 - 32.9)^2}{32.9} + \ldots\ldots \qquad \text{(M2)}$$

    $= 7.77$ (3 s.f.) [or 7.79 from GDC]   (A1)

    But $\chi^2_{5\%}(2) = 5.99$ (from table)   (M1)

    $\chi^2 = 7.77 > \chi^2_{5\%}(2)$ and we do reject H_0 (A1)(R1)

    Hence: Choice of game is dependent on gender.   (A1)   13

(b) (i)   The frequency for males choosing Billiards is less than 5   (R1)

     (ii) Snooker – In order to preserve the diversity of games   (R1)
           OR
           Darts – it has the next smallest number of members   (R1)   2

(c) (i) $\dfrac{31}{122}$ ***or*** 0.254 (3 s.f.)   (A1)

     (ii) $\dfrac{72}{122}$ ***or*** 0.590 (3 s.f.)   (A1)   2

[17]