

1. (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) $\frac{28 \times 45}{100} = 12.6 = 13$ or $\frac{28}{100} \times \frac{25}{100} \times 100 = 12.6 = 13$ (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]

2. (a) (i) 50 (G1)
- (ii) 16.8 (G1)
- (iii) 30.5 (G1)
- (iv) 12.3 (G1)
Note: Award (A1)(ft) for 13.0 in (iv) but only if 17.7 seen in (a)(ii).
- (b) $r = \frac{188.5}{(16.79 \times 12.33)}$ (M1)
 = 0.911 (accept 0.912, 0.910) (A1)(ft)(G2)
Note: Award (M1) for using their values in the correct formula
- (c) $y = 0.669x - 2.95$ (G1)(G1)

Note: Award (G1) for $0.669x$, (G1) for -2.95 . If the answer is not in the form of an equation, award at most (G1)(G0).

(d) $\text{Depth} = 0.669 \times 55 - 2.95$ (M1)
 $= 33.8$ (A1)(ft)(G2)(ft)

Note: Follow through from their (c) even if no working seen.

(e) (i) 64.0 (accept 63.95, 63.9) (A1)(ft)(G1)(ft)

Note: Follow through from their (c) even if no working seen.

(ii) It is not valid. It lies too far outside the values that are given. *Or equivalent.* (A1)(R1)

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

[13]

3. (a) 28 (A1)

(b) $\frac{28 \times 45}{100} \left(\frac{28}{100} \times \frac{45}{100} \times 100 \right)$ (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]

4. (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) $\frac{98 \times 45}{200} = 22.05 = 22$ (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)

$\chi_{crit}^2 < 8.12$ or $p\text{-value} < 0.05$ (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) $\frac{98}{200}$ (= 0.49, 49%) (A1)(A1)(G2)

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

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

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

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

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

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

(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

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

(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]

5. (a) 0.965 (A1) (C1)

(b) $y = 1.15x + 0.976$
 (A1) for 1.15x (A1) for +0.976 (A1)(A1) (C2)

(c) $y = 1.15(7) + 0.976$ (M1)
 Chemistry = 9.03 (accept 9) (A1)(ft) (C2)

Note: Follow through from candidate's answer to (b) even if no working is seen. Award (A2)(ft).

(d) the correlation coefficient is close to 1
OR strongly correlated variables
OR 7 lies within the range of physics marks. (R1) (C1)

[6]

6. (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) $\frac{365 \times 217}{751}$ (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]

7. (a) $a = -0.134, b = 20.9$ (A1)
 $y = 20.9 - 0.134x$ (A1) (C2)

(b) 17 objects (A1)(ft) (C1)

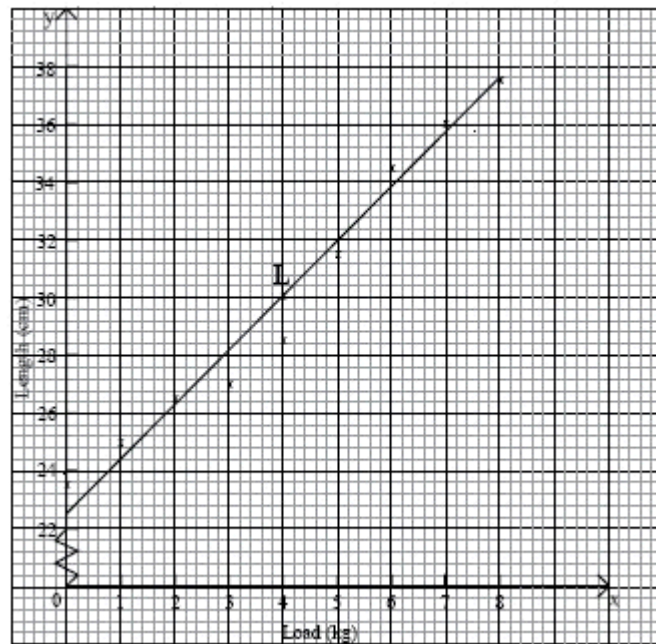
Note: Accept only 17

(c) $r = -0.756$ (A1) (C1)

(d) negative and moderately strong (A1)(ft)(A1)(ft) (C2)

[6]

8. (a)



(A4)

Note: Award (A1) for correct scales and labels, (A3) for correct points, (A2) for 7 or 8 correct, (A1) for 5 or 6 correct.

- (b) (i) 4 (G1)
(ii) 2.58 (G1)
(iii) 30 (G1)
(iv) 4.78 (G1)

Note: If wrong version of s.d. used in (ii), can (ft) in (iv) (5.07).

(c) L correctly plotted on graph and named (A1)(ft)

(d) (i) $r = 0.986$ (0.987) (G1)
(ii) (very) strong positive correlation (R1)(ft)(R1)(ft)

(e) $y = 1.83x + 22.7$ ($y = 1.825x + 22.7$) (G1)(G1)
Award (G1) for $y = 1.83x$ (1.825x), (G1) for 22.7

(f) Line drawn on graph. (A1)(A1)(ft)
Note: Award (A1) for passing through the mean point, (A1) for y intercept between 22 and 23.

(g) (i) 32.6 cm (A1)(ft)

Note: Allow margin of error of 0.2 from value on candidate's diagram.

(ii) Not possible to find an answer as the value lies too far outside the given set of data. (R1)

[18]

9. (a) $H_0 =$ The standard of award is independent of the examiner (or equivalent) (A1) (C1)

(b) 4 (A1) (C1)

(c) $f_e = \frac{30 \times 45}{135}$ (M1)

$f_e = 10$ (A1) (C2)

(d) No, because the p -value is less than the significance level. (A2)

OR

No, because $0.0327 < 0.05$ (A2) (C2)

[6]

10. (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)

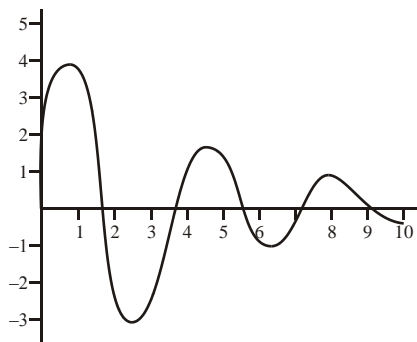
For < or saying "less than" (M1)

Reject H_0 (A1)

Time and outcome are not independent of each other, or equivalent in words relating to the question (A1) (C4)

[6]

11. (a)



For labels and scales.

3 maxima drawn.

2 minima drawn.

General shape

(A1)

(A1)

(A1)

(A2) 5

(b) (0.827, 4.12)

(G2) 2

(c) 0, 1.8, 3.6, 5.4, 7.2, 9 (for any one of these answers).

(G1) 1

(d) $r = 1$

Perfect positive correlation.

(G2)

(R1) 3

(e) $y = 3x$ (accept $y = 3x + 0.000274$)

(G2) 2

(f) line on graph

(A1) 1

(g) (0, 0) or (1.16, 3.48)

(G1) (G1) 2

[16]

12. (a) Colour of car and gender are independent

(A1) (C1)

(b) $(2 - 1)(5 - 1)$
= 4

(M1)

(A1)

OR

4

(A2) (C2)

(c) $\chi^2 = 9.488$

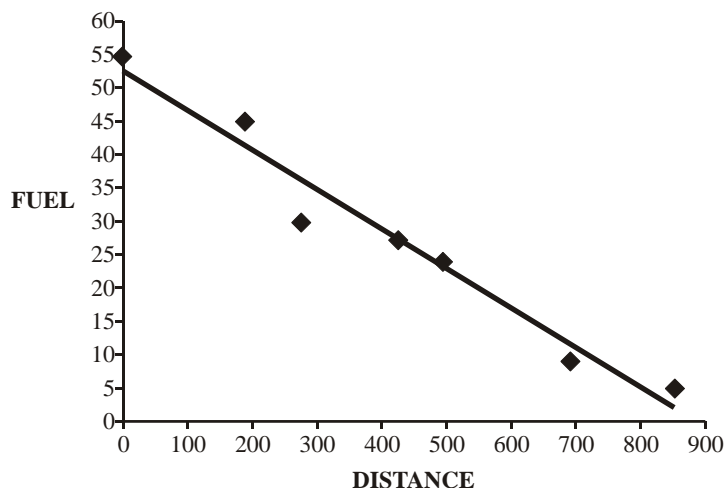
(A1) (C1)

(d) Yes. Test statistic is smaller than the critical value.

(A1)(R1) (C2)

[6]

13. (a)



For all 3 points correct

(A2) (C2)

Note: If only 2 points correct award (A1).

- (b) For straight line **with -ve gradient** for passing through the mean (A1)(A1)
 For straight line intercept on y-axis between 50 and 55 (A1) (C3)
- (c) 32 (read answer from candidate's line) (A1) (C1)

[6]

14. (a) $y = 0.070x - 3.22$ (G3) 3
Notes: Award (G1) for correct m value, (G1) for 3.22, (G1) for negative sign. Accept 0.07x.

- (b) $y = 0.070 \times 162 - 3.22$ (M1)
 $= 8.12$
 Therefore shoe size 8 or 9 (8.12). (A1)
- OR**
- $y = 8$ or 9 (G2) 2

- (c) $r = 0.681$ (A1) 1

- (d) Moderately strong, positive correlation. (A1)(A1) 2

[8]

15. (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
16. (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) $\frac{(30-32)^2}{32} + \dots$ (M1)(A1)
 $= 6.10$ (using given values) (A1)
- OR**
 5.80 (from calculator) (G3) 3

[7]

- (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]

17. (a) mean of $x = 72.25$ (A1)
sd of $x = 4.41$ (A1)
mean of $y = 139.7$ (140) (A1)
sd of $y = 5.99$ (A1) 4

- (b) $r = -0.940$ (G2)

OR

$$r = \frac{-24.82}{(4.41 \times 5.99)}$$

$$= -0.9396 (= -0.94) \quad (M1)(A1) \quad 2$$

- (c) strong, negative correlation (A2) 2

Note: Award (A1) for negative, (A1) for strong.

- (d) $y = 232 - 1.28x$ (G3)

OR

$$(y - 139.7) = -\frac{24.82}{4.41^2}(x - 72.25)$$

$$y = -1.28x + 232 \quad (M1)(A1)(A1) \quad 3$$

- (e) $y = 232 - 1.28 \times 75 = 136$ seconds (A1) 1

[12]

18. (a) Males = $\frac{9000 \times 11000}{20000}$ (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]

19. (a) (i) ① (A1)
- (ii) ③ (A1) 2
- (b) (i) ① 0.04 (A1)
② -0.20 (A1)
③ -0.85 (A1)
- (ii) 1.60 A product-moment correlation coefficient cannot be
greater than 1. (R1)
0.90 There is no diagram with a strong positive correlation. (R1) 5
- (c) (i) Product-moment correlation = $\frac{55.00}{6.08 \times 10.50}$ (A1)
= 0.8615
= 0.862 (A1)

(ii) $\bar{t} = \frac{124}{20} = 6.2$ $\bar{w} = \frac{250}{20} = 12.5$ (both correct) (A1)

$$w - \bar{w} = \frac{S_{tw}}{S_t^2} (t - \bar{t})$$

$$(w - 12.5) = \frac{55.00}{(6.08)^2} (t - 6.2)$$
 (M1)(A1)
$$w - 12.5 = 1.4878(t - 6.2)$$

$$w = 1.49t + 3.28$$
 (A1)(A1) 7

Note: ft from candidate's mean values

[14]

20. (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]

21. (a) (i) 1992 mean = \$1.59, Sd = \$0.727 (or 0.73) (A1) (A1)
(accept 0.777 or 0.78)

(ii) 2002 mean = \$1.98, Sd = \$0.635 (or 0.64) (A1) (A1) 4
(accept 0.679 or 0.68)

(b) (i) $r = \frac{0.3104}{0.73 \times 0.64} = 0.664$ (or $\frac{0.3104}{0.727 \times 0.635} = 0.672$) $\left(\text{or } \frac{0.3104}{0.777 \times 0.679} = 0.588 \right)$

(M1) (A1)

OR

$$R = 0.672$$

(G2)

(ii) There is a **weak positive** correlation

(R1) (R1)

4

(c) $y - 1.98 = \frac{0.3104}{(0.73)^2}(x - 1.59)$

(M1)

$$y = 0.582x + 1.05$$

(A1) (A1)

OR

$$y = 1.98 = \frac{0.3104}{(0.727)^2}(x - 1.59)$$

(M1)

$$y = 0.587x + 1.05$$

(A1) (A1)

OR

$$y = 0.588x + 1.05$$

(G3)

3

(d) $y = 0.582 \times 2.60 + 1.05$
 $= \$2.56$

(A1)

OR

$$y = 0.587 \times 2.60 + 1.05$$

 $= \$2.58$

(A1)

OR

$$y = 0.588 \times 2.60 + 1.05$$

 $= \$2.58$

(A1)

1

(e) Coffee – because it is the only item to go down in price.

(A1) (R1)

OR

Rolls – because the price increased significantly.

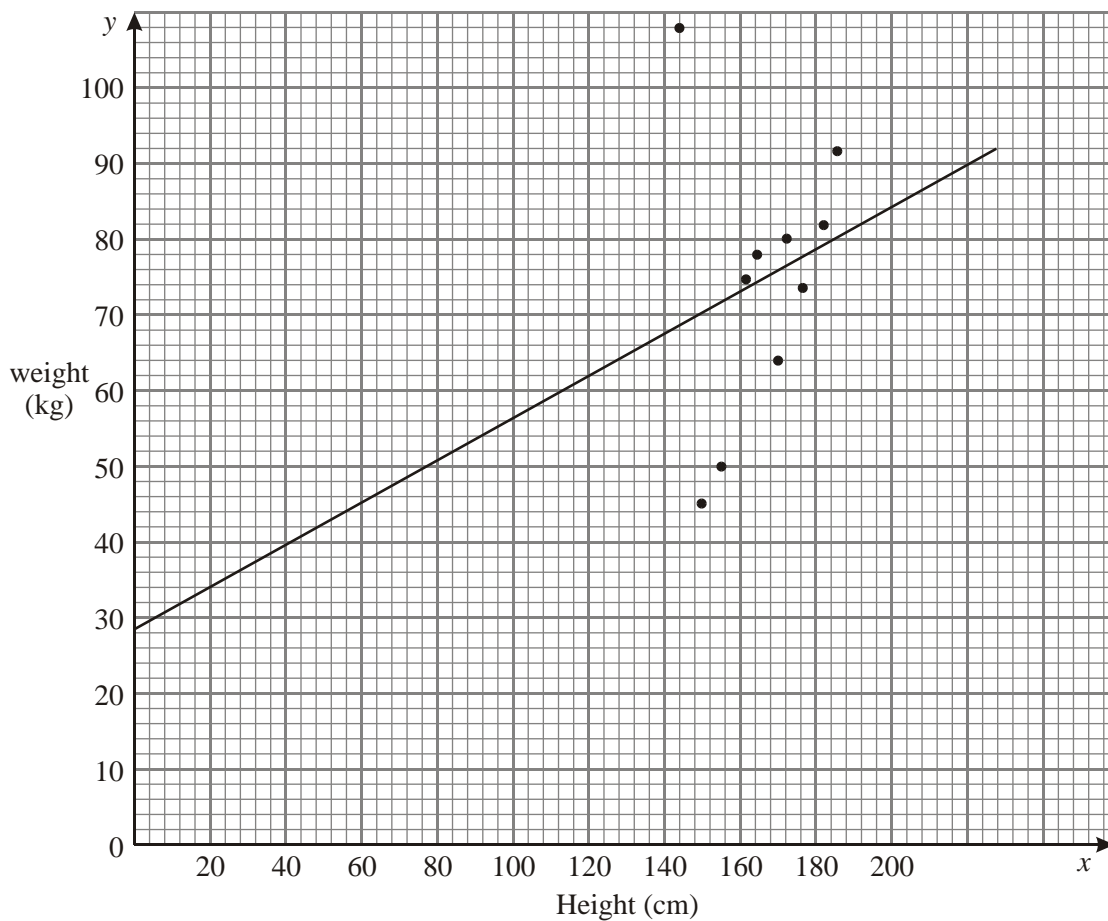
(A1) (R1)

2

[14]

22. (a)

x	155	161	173	150	182	165	170	185	175	145
y	50	75	80	46	81	79	64	92	74	108



(A2)(A2) 4

Notes: Award (A1) for axes correctly labelled, and (A1) for correct scales.

Award (A1) for 4, 5 6, or 7 correctly plotted points, (A2) for 8 or more.

(b) Mean height = $166.1 = 166$ (3 s.f.) (A1) 1

(c) Mean weight = 74.9 (3 s.f.) (A1) 1

(d) (i) $S_x = 12.68$ (A1)
 Gradient = $\frac{S_{xy}}{S_x^2} = \frac{44.31}{(12.68)^2} = 0.276$ (M1)(AG)

(ii) $y - 74.9 = 0.276(x - 166)$ (M1)
 $y = 0.276x + 29.1$ (A1)

OR

$y = 0.276x + 29.1$ (G2)

(iii) Line on graph. (A2) 6
Note: Award (A1) for the y-intercept at 29.1, and (A1) for a straight line through (166, 74.9).

(e) (i) $y = 0.276 \times 190 + 29.1$ (A1)
 $= 81.5 \text{ kg}$

(ii) $72 = 0.276x + 29.1$
 $x = \frac{72 - 29.1}{0.276}$
 $= 155 \text{ cm.}$ (A1)

OR

From the graph (A1)

(i) $y = 81 (\pm 1)$ (A1)

(ii) $x = 155 (\pm 1)$ (A1) 2

Note: Follow through with candidate's line.

(f) The "line of best fit" becomes closer to the remaining points. (R1)

OR

Gradient becomes steeper and the line is more accurate 'best fit'. (R1)

OR

Any reasonable explanation. (Line becomes $y = 1.10x - 113$) (R1) 1

[15]

23. (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]

24. (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)

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e} = \frac{(39 - 32.9)^2}{32.9} + \dots \quad (\text{M2})$$

$$= 7.77 \text{ (3 s.f.) [or 7.79 from GDC]} \quad (\text{A1})$$

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

$\chi^2 = 7.77 > \chi_{5\%}^2(2)$ 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) $\frac{31}{122}$ **or** 0.254 (3 s.f.) (A1)

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

[17]

25. (a) II (A1) (C1)

(b) V (A1) (C1)

(c) III (A1) (C1)

(d) I (A1) (C1)

[4]

26. (a) High positive *or* high *or* positive *or* good *correlation* etc. (A1)

Note: For (A1) accept any correct answer.

(b) Correct point M(29, 31) (A1)

(c) Suitable line which should pass through the candidate's M and have nearly as many crosses (plotted points) below it as above it. (A1)

(d) Accept **only** value (including non-integers) obtained using candidate's line of best fit.
(Follow through from part (c).) (A1)

[4]

27. (a) For applying $r = \frac{S_{xy}}{(S_x)(S_y)}$ or any correct formulae. (M1)

For: $S_x = 4.0034568... \approx 4$ (M2)

$S_y = 13.992456... \approx 14$ (M2)

$r = 0.6399706... \approx 0.64$ (2 d.p.) (A1) 6

Note: Follow through with candidate's $S_x + S_y$.

Accept solutions that use the unbiased estimates for the population standard deviations.

(b) This indicates that there is a degree of positive correlation between scores in Mathematics and scores in English. (R1)

Note: Follow through using candidate's v, χ^2

and $\chi^2_{5\%}(v)$ from table.

Therefore those who do well in Mathematics are likely to do well in English also. (Or equivalent statements.) (R1) 2

[8]