Topic 4 Part 1 *[219 marks]*

1a. *[1 mark]*

Markscheme

H_0: Choice of morning snack is independent of (not dependent on) gender.   *(A1)*   *(C1)*

Note: Accept there is "no association" between snack chosen and gender.

Do not accept "not related" or "not correlated" or "influenced".

Examiners report

[N/A]

1b. *[1 mark]*

Markscheme

2   *(A1)*   *(C1)*

Examiners report

[N/A]

1c. *[2 marks]*

Markscheme

$\frac{210 \times 150}{350}$ *(M1)*

Note: Award *(M1)* for correct substitution in the correct formula.

$= 90$ *(A1)*   *(C2)*

Examiners report

[N/A]

1d. *[2 marks]*

Markscheme

Null hypothesis is accepted (not rejected).   *(A1)*

OR

Choice of morning snack is independent of gender   *(A1)*

$3.576 < 5.99$ OR $\chi^2_{\text{calc}} < \chi^2_{\text{crit}}$ *(R1)*   *(C2)*

Note: Do not award *(A1)(R0)*.
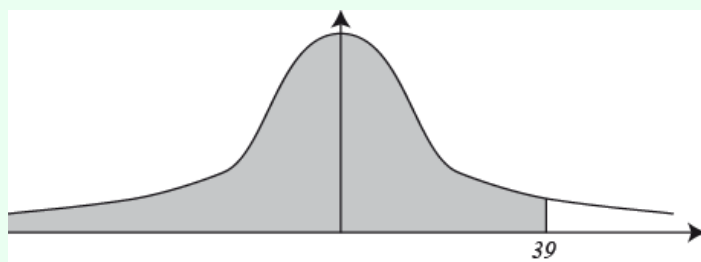
Examiners report

[N/A]

2a. [2 marks]

Markscheme

(M1)

Note: Award **(M1)** for correctly shaded area.

$0.952 \ (95.2\%, \ 0.952209\ldots)$ **(A1)**   **(C2)**

Examiners report

[N/A]

2b. [2 marks]

Markscheme

$31 \times (1 - 0.952209)$ **(M1)**

Note: Award **(M1)** for multiplying
31 by $(1 - \text{their answer to part (a)})$.

$= 1.48 \ (1.48150\ldots)$ **(A1)(ft)**   **(C2)**

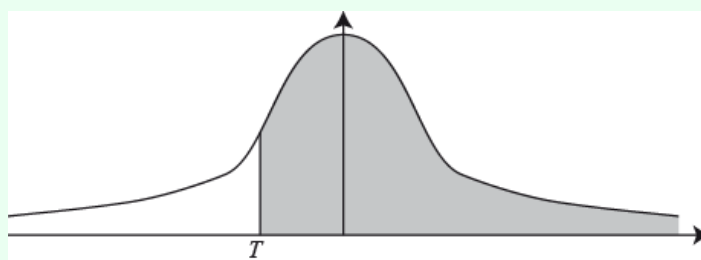**Note:** Follow through from part (a).

Examiners report

[N/A]

2c. [2 marks]

Markscheme

(M1)

Note: Award **(M1)** for correctly shaded area.

$32.4 \ (32.4267\ldots)$ **(A1)**   **(C2)**

Examiners report

[N/A]

3a.

[4 marks]

Markscheme

(i) -0.998 $(-0.997770\ldots)$ **(A2)**

Note: Award **(A0)(A1)** for $0.998(0.997770\ldots)$.

Award **(A1)(A0)** for -0.997.

(ii) $y = -0.470x + 81.7$ $(y = -0.469713\ldots x + 81.7279\ldots)$ **(A1)(A1)** **(C4)**

Note: Award a maximum of **(A0)(A1)** if the answer is not an equation.

Examiners report

In part (a)(i), the majority of candidates knew how to calculate Pearson's correlation coefficient using their GDC. The most common errors were incorrect rounding and omitting the – sign. In part (a)(ii) many candidates correctly found the equation of the regression line, again with rounding errors being the most common. A very common error was to use the second list as the frequency for the statistics.

3b.

[2 marks]

Markscheme

$-0.469713\ldots(28) + 81.7279$ **(M1)**

Note: Award **(M1)** for correct substitution of 28 into their equation of regression line.

$= 68.6 \,(\text{mosquitoes})$ $(68.5759\ldots)$ **(A1)(ft)** **(C2)**

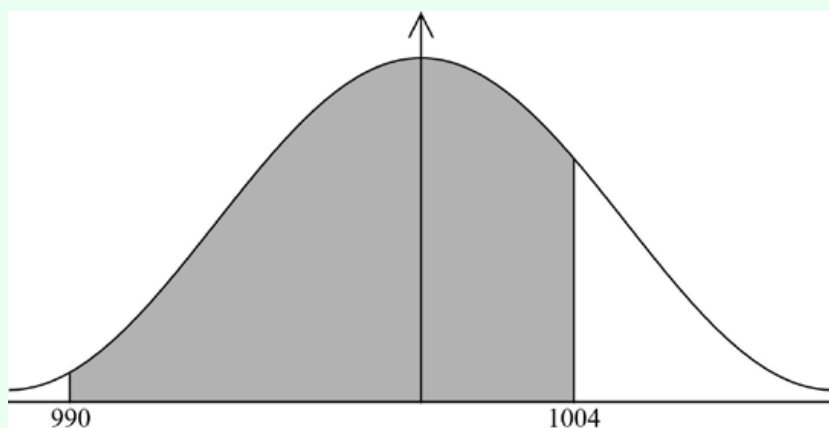**Note:** Accept 68 or 69 or $68.5(4)$ from use of 3 sf values.

Follow through from part (a)(ii).

Examiners report

In part (b) substitution of 28 in the regression line was done correctly by many candidates. Candidates seemed to be well prepared for this type of question.

4a.

[2 marks]

Markscheme

(M1)

Note: Award **(M1)** for approximate curve with 990 and 1004 in correct place.

0.835 $(0.835135\ldots, 83.5\%)$ **(A1)** **(C2)**

4b.   *[2 marks]*

Markscheme

(M1)

Note: Award **(M1)** for approximate curve with k placed to the right of the mean.

1010 $(1006.57\ldots)$ **(A1)** **(C2)**

Note: Award full marks **only** for 1010, 1007 or an answer with more than 4 sf resulting from **correct** rounding of $1006.57\ldots$.
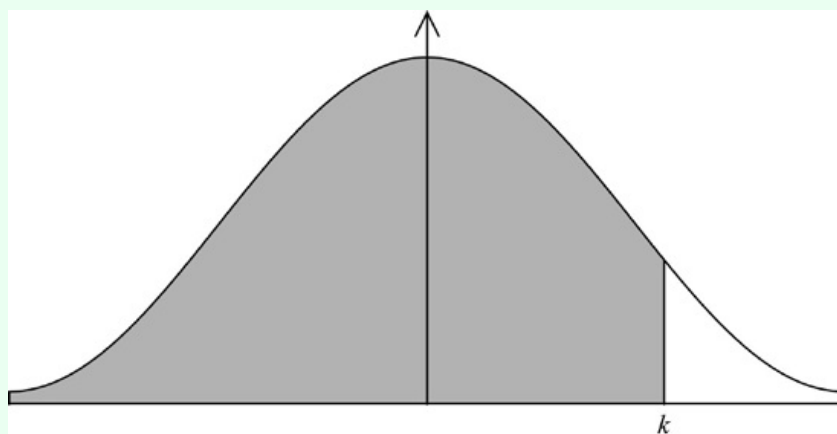
Examiners report

A significant number of candidates did not answer this question. It was very rare that a correct method was shown for any of the parts of this question. Often a normal distribution graph was drawn with indication of the mean and multiples of the standard deviation, with indication of the corresponding probabilities, but not a diagram identifying the area under the curve corresponding to the questions. There were however many correct answers for part (a). For part (b) many answered incorrectly; the most common incorrect answer was 1008, resulting from adding 2 sd to the mean. Very few correct answers were given for part (c).

4c.

Markscheme

(M1)

Note: Award **(M1)** for some indication of symmetry on diagram.

OR

$P(W < 1000 - a) = 0.05$ **OR** $P(W > 1000 + a) = 0.05$ **(M1)**

Note: Award **(M1)** for probability with single inequality resulting from symmetry of diagram.

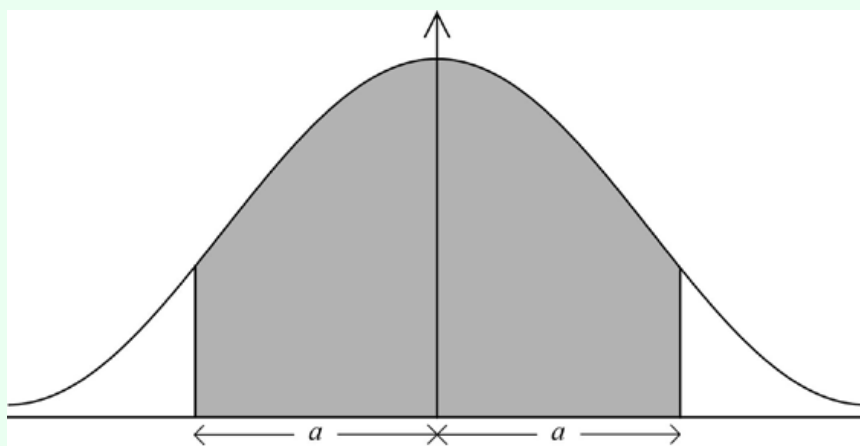$(a =) 6.58 \quad (6.57941\ldots)$ **(A1)** **(C2)**

Examiners report

A significant number of candidates did not answer this question. It was very rare that a correct method was shown for any of the parts of this question. Often a normal distribution graph was drawn with indication of the mean and multiples of the standard deviation, with indication of the corresponding probabilities, but not a diagram identifying the area under the curve corresponding to the questions. There were however many correct answers for part (a). For part (b) many answered incorrectly; the most common incorrect answer was 1008, resulting from adding 2 sd to the mean. Very few correct answers were given for part (c).

5a.

Markscheme

H_0 the type of Latin dance the viewer prefers is independent of their age **(A1)** **(C1)**

Notes: Accept "not dependent" or "not associated". Do not accept "not correlated" or "not related" or "not connected".

Examiners report

[N/A]

5b.

Markscheme

18 **(A1)** **(C1)**

Examiners report

[N/A]

5c. [2 marks]

Markscheme

$p = 0.0876 \quad (0.0875813\ldots)$ **(A2)** **(C2)**

Notes: Award **(A2)** for 0.088.

    Award **(A1)(A0)** for an answer of 0.0875.

Examiners report

[N/A]

5d. [2 marks]

Markscheme

$0.05 <$ their p-value   **(R1)**

the producer's claim is justified   **(A1)(ft)**   **(C2)**

Notes: Do not award **(R0)(A1)(ft)**. Follow through from their answer to (c). If there is no answer in part (c), award **(R1)(A0)** for stating the relationship between the independence **and** the p-value compared to 0.05.

    If **(R1)** is awarded, award **(A1)(ft)** for the answer 'yes' or the answer 'no' if it is consistent with their reasoning.

    Similarly, allow 'accept H_0' or 'reject H_0' if consistent with their reasoning.

    Award **(R0)** for comparing p with the critical value.

Examiners report

[N/A]

6a. [2 marks]

Markscheme
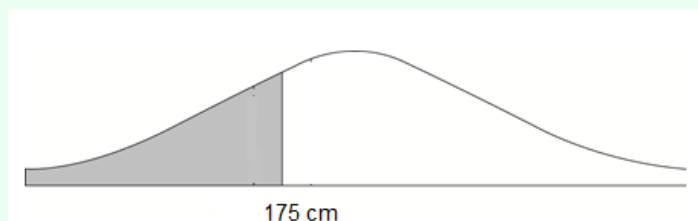
(A1)(M1)   **(C2)**

175 cm

Notes: Award **(A1)** for the vertical line labelled as 175 (cm).

    Award **(M1)** for a vertical line drawn to the left of the mean with the area to the left of this line shaded.

    Accept $(-)1$ sd marked on the diagram for 175 (provided line is to the left of the mean).

Examiners report

[N/A]

6b.   [4 marks]

Markscheme

(i) 185 (cm)   **(A1)(C1)**

(ii) $P(\text{length} > 185)$ **(A1)(M1)**

Note: Award **(A1)** for the vertical line labelled as 185 (cm).

Award **(M1)** for a vertical line drawn to the right of the mean with the area to the right of this line shaded.

Accept 1 sd marked on the diagram for 185 (provided line is to the right of the mean).

$= 0.159$ $(0.158655\ldots)$ **(A1)**   **(C3)**

Examiners report

[N/A]

7a.   [2 marks]

Markscheme

(i)
H_0 age and opinion (about the reduction) are independent.   **(A1)**

Notes: Accept "not associated" instead of independent.

(ii)
H_1 age and opinion are not independent.   **(A1)(ft)**

Notes: Follow through from part (a)(i). Accept "associated" or "dependent".

Award **(A1)(ft)** for their correct
H_1 worded consistently with their part (a)(i).

Examiners report

The great majority of candidates found this question to be a good start to the paper, with many perfect scores accruing. A common problem was the inability to form consistent null and alternative hypotheses. Also, calculating the expected value "by hand" as part of a "show that" question was left blank by a number of candidates; to reiterate again – to attain full marks, both the unrounded and the consistent and correctly rounded answer must be stated.

And, lastly, incorrect comparison of statistics when forming a conclusion was a common fault.

7b.   [1 mark]

Markscheme

2 **(A1)**

Examiners report

The great majority of candidates found this question to be a good start to the paper, with many perfect scores accruing. A common problem was the inability to form consistent null and alternative hypotheses. Also, calculating the expected value "by hand" as part of a "show that" question was left blank by a number of candidates; to reiterate again – to attain full marks, both the unrounded and the consistent and correctly rounded answer must be stated.

And, lastly, incorrect comparison of statistics when forming a conclusion was a common fault.

7c. *[2 marks]*

Markscheme

$\frac{80}{130} \times \frac{35}{130} \times 130$ **OR** $\frac{80 \times 35}{130}$ **(M1)**

Note: Award **(M1)** for $\frac{80}{130} \times \frac{35}{130} \times 130$ **OR** $\frac{80 \times 35}{130}$ seen. The following **(A1)** cannot be awarded without this statement.

$= 21.5384\ldots$ **(A1)**

$= 21.5$ **(AG)**

Note: Both an unrounded answer that rounds to the given answer and rounded must be seen for the **(A1)** to be awarded. Accept 21.54 or 21.53 as an unrounded answer.

Examiners report

The great majority of candidates found this question to be a good start to the paper, with many perfect scores accruing. A common problem was the inability to form consistent null and alternative hypotheses. Also, calculating the expected value "by hand" as part of a "show that" question was left blank by a number of candidates; to reiterate again – to attain full marks, both the unrounded and the consistent and correctly rounded answer must be stated.

And, lastly, incorrect comparison of statistics when forming a conclusion was a common fault.

7d. *[3 marks]*

Markscheme

(i) χ^2 statistic $= 10.3$ $(10.3257\ldots)$ **(G2)**

Note: Accept 10 as a correct 2 significant figure answer.

(ii)
p-value $= 0.00573$ $(0.00572531\ldots)$ **(G1)**

Examiners report

The great majority of candidates found this question to be a good start to the paper, with many perfect scores accruing. A common problem was the inability to form consistent null and alternative hypotheses. Also, calculating the expected value "by hand" as part of a "show that" question was left blank by a number of candidates; to reiterate again – to attain full marks, both the unrounded and the consistent and correctly rounded answer must be stated.

And, lastly, incorrect comparison of statistics when forming a conclusion was a common fault.

7e. *[2 marks]*

Markscheme

since p-value < 0.01, H_0 should not be accepted   **(R1)(A1)(ft)**

OR

since χ^2 statistic $> \chi^2$ critical value, H_0 should not be accepted   **(R1)(A1)(ft)**

Note: Do not award **(R0)(A1)**. Follow through from their answer to part (d). Award **(R0)(A0)** if part (d) is unanswered.

Award **(R1)** for a correct comparison of either their p-value to the test level or their χ^2 statistic to the χ^2 critical value, award **(A1)** for the correct result from that comparison.

8a.   *[3 marks]*

Markscheme

(i) 6.76 (cm)   **(G2)**

Notes: Award **(M1)** for an attempt to use the formula for the mean with a least two rows from the table.

(ii) 1.14 (cm) $(1.14122\ldots$ (cm))   **(G1)**

Examiners report

[N/A]

8b.   *[3 marks]*

Markscheme

$P(\text{diameter} < 6.5) = 0.338$ (0.338461) **(M1)(A1)**

Notes: Award **(M1)** for attempting to use the normal distribution to find the probability **or** for correct region indicated on labelled diagram. Award **(A1)** for correct probability.

$33.8(\%)$ **(A1)(ft)(G3)**

Notes: Award **(A1)(ft)** for converting their probability into a percentage.

Examiners report

[N/A]

8c.   *[2 marks]*

Markscheme

$P(\text{diameter} \geqslant a) = 0.05$ **(M1)**

Note: Award **(M1)** for attempting to use the normal distribution to find the probability **or** for correct region indicated on labelled diagram.

$a = 8.97$ (cm) $(8.97382\ldots)$ **(A1)(G2)**

Examiners report

[N/A]

8d.

Markscheme

$100 - (5 + 33.8461\ldots)$ **(M1)**

Note: Award **(M1)** for subtracting "
$5+$ their part (b)" from 100 **or (M1)** for attempting to use the normal distribution to find the probability $\mathrm{P}\,(6.5 \leqslant \text{diameter} < \text{their part (c)})$ **or** for correct region indicated on labelled diagram.

$= 61.2(\%)$ $(61.1538\ldots(\%))$ **(A1)(ft)(G2)**

Notes: Follow through from their answer to part (b). Percentage symbol is not required. Accept $61.1(\%)$ ($61.1209\ldots(\%)$) if 8.97 used.

Examiners report

[N/A]

8e.

Markscheme

$100\,000 \times 0.05$ **(M1)**

Note: Award **(M1)** for multiplying by 0.05 (or 5%).

$= 5000$ **(A1)(G2)**

Examiners report

[N/A]

9a.

Markscheme

(i) $r = 0.985$ $(0.984905\ldots)$ **(G2)**

Notes: If unrounded answer is not seen, award **(G1)(G0)** for 0.99 or 0.984. Award **(G2)** for 0.98.

(ii)   strong, positive   **(A1)(A1)**

Examiners report

[N/A]

9b.

Markscheme

$y = 259.909\ldots x + 698.648\ldots$ $(y = 260x + 699)$ **(G1)(G1)**

Notes: Award **(G1)** for $260x$ and **(G1)** for 699. If the answer is not an equation award a maximum of **(G1)(G0)**.

Examiners report

[N/A]

Markscheme

$y = 259.909\ldots \times 13 + 698.648\ldots$ *(M1)*

Note: Award *(M1)* for substitution of 13 into their regression line equation from part (b).

$y = 4077.47\ldots$ *(A1)(ft)(G2)*

$y = 4077 \ (\text{USD})$ *(A1)(ft)*

Notes: Follow through from their answer to part (b). If rounded values from part (b) used, answer is 4079. Award the final *(A1)(ft)* for a correct rounding to the nearest USD of their answer. The unrounded answer may not be seen.

If answer is 4077 and no working is seen, award *(G2)*.

Examiners report

[N/A]

Markscheme

$y = 259.909\ldots \times 13 + 698.648\ldots$ *(M1)*

Note: Award *(M1)* for substitution of 13 into their regression line equation from part (b).

$y = 4077.47\ldots$ *(A1)(ft)(G2)*

$y = 4077 \ (\text{USD})$ *(A1)(ft)*

Notes: Follow through from their answer to part (b). If rounded values from part (b) used, answer is 4079. Award the final *(A1)(ft)* for a correct rounding to the nearest USD of their answer. The unrounded answer may not be seen.

If answer is 4077 and no working is seen, award *(G2)*.

Markscheme

$13 \times 304 - (4077.47) = -125.477\ldots$ (-125) **OR**

$4077.47 - (13 \times 304) = 125.477\ldots$ (125) *(M1)*

Notes: Award *(M1)* for calculating the difference between 13×304 and their answer to part (c).

   If rounded values are used in equation, answer is -127.

profit is negative   **OR** $\text{cost} > \text{sales}$ *(A1)*

OR

$13 \times 304 = 3952$ *(M1)*

Note: Award *(M1)* for calculating the price of 13 bikes.

$3952 < 4077.47$ *(A1)(ft)*

Note: Award *(A1)* for showing 3952 is less than their part (c). This may be communicated in words. Follow through from part (c), but only if value is greater than 3952.

OR

$\frac{4077}{13} = 313.62$ *(M1)*

Note: Award *(M1)* for calculating the cost of 1 bicycle.

$313.62 > 304$ *(A1)(ft)*

Note: Award *(A1)* for showing 313.62 is greater than 304. This may be communicated in words. Follow through from part (c), but only if value is greater than 304.

OR

$\frac{4077}{304} = 13.41$ *(M1)*

Note: Award *(M1)* for calculating the number of bicycles that should have been be sold to cover total cost.

$13.41 > 13$ *(A1)(ft)*

Note: Award *(A1)* for showing 13.41 is greater than 13. This may be communicated in words. Follow through from part (c), but only if value is greater than 13.

Examiners report

[N/A]

9e.

Markscheme

(i) $304x$ *(A1)*

(ii) $304x - (259.909\ldots x + 698.648\ldots)$ *(A1)(ft)(A1)(ft)*

Note: Award *(A1)(ft)* for difference between their answers to parts (b) and (e)(i), *(A1)(ft)* for correct expression.

(iii) $304x - (259.909\ldots x + 698.648\ldots) > 0$ *(M1)*

Notes: Award *(M1)* for comparing their expression in part (e)(ii) to 0. Accept an equation. Accept $3040x - y > 0$ or equivalent.

$x = 16$ bicycles   *(A1)(ft)(G2)*

Notes: Follow through from their answer to part (b). Answer must be a positive integer greater than 13 for the *(A1)(ft)* to be awarded.

Award *(G1)* for an answer of 15.84.

Examiners report

[N/A]

10a.

Markscheme

$\frac{30}{100} \times \frac{48}{100} \times 100$ **OR**
$\frac{30 \times 48}{100}$ *(M1)*

Note: Award *(M1)* for correct substitution into correct formula.

$= 14.4 \left(\frac{72}{5}\right)$ *(A1)*   *(C2)*

[2 marks]

Examiners report

[N/A]

10b.

Markscheme

$13.0\ (12.9554\ldots)$ *(A2)*   *(C2)*

Note: Award *(A1)(A0)* for
12.9.

[2 marks]

Examiners report

[N/A]

10c.

Markscheme

the null hypothesis is not accepted   *(A1)(ft)*

$\chi^2_{calc} > \chi^2_{crit}$ **OR**

$13.0 > 7.82$ *(R1)*

OR

the null hypothesis is not accepted   *(A1)(ft)*

p-value

$(0.0047) (0.00473391\dots) < 0.05$ *(R1)*   *(C2)*

Notes: Follow through from their answer to part (b).

    Do not award *(A1)(ft)(R0)*.

[2 marks]

Examiners report

[N/A]

11a.

Markscheme

$t = -20.1n + 205$

$t = (-20.1046\dots)n + (204.755\dots)$ *(A1)(A1)*   *(C2)*

Notes: Award *(A1)* for

-20.1 and

205 seen,

    (A1) for an equation involving

t and

n.

[2 marks]

Examiners report

[N/A]

11b.

Markscheme

$-0.941(-0.941366\dots)$ *(A2)*   *(C2)*

Notes: Award *(A0)(A1)* for

$+0.941$.

[2 marks]

Examiners report

[N/A]

11c. *[2 marks]*

Markscheme

$-20.1046\ldots \times 4 + 204.755\ldots$ *(M1)*

Note: Award *(M1)* for substitution into their regression equation.

124 (minutes) (
124.337…)   *(A1)(ft)*   *(C2)*

Notes: Follow through from their regression equation found in part (a). Accept
125 (minutes) (
124.6).

[2 marks]

Examiners report

[N/A]

12a. *[1 mark]*

Markscheme

$0.5\ \left(50\%,\ \frac{50}{100},\ \frac{1}{2}\right)$ *(A1)*   *(C1)*
[1 mark]

Examiners report

[N/A]

12b. *[1 mark]*

Markscheme

$0.954(0.954499\ldots, 95.4\%, 95.4499\ldots\%)$ *(A1)*   *(C1)*

Note: Accept
95% or
0.95.

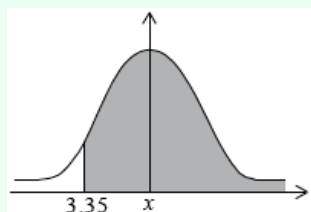*[1 mark]*

Examiners report

[N/A]

12c.   [2 marks]

Markscheme

(M1)

Note: Accept alternative methods.

$0.631 (0.630558\ldots, 63.1\%, 63.0558\ldots\%)$ *(A1)   (C2)*
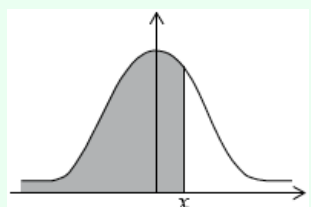*[2 marks]*

Examiners report

[N/A]

12d.   [2 marks]

Markscheme

(M1)

Note: Accept alternative methods.

3.50 (3.50091...)   *(A1)   (C2)*
[2 marks]

Examiners report

[N/A]

13a.   [1 mark]

Markscheme

Country chosen and gender are independent.   *(A1)   (C1)*

Notes: Accept there is no association between country chosen and gender.
    Do not accept "not related" or "not correlated" or "influenced".

[1 mark]

Examiners report

[N/A]

13b.   [1 mark]

Markscheme

2   *(A1)*   *(C1)*

[1 mark]

Examiners report

[N/A]

13c.   [2 marks]

Markscheme

(i)   9.17 (9.16988…)   *(A1)*

Notes: Accept 9.169.

(ii)   0.0102 (0.0102043…)   *(A1)*   *(C2)*

Notes: Award *(A1)* for 0.010, but *(A0)* for 0.01.

[2 marks]

Examiners report

[N/A]

13d.   [2 marks]

Markscheme

Since

$0.0102 > 0.01$, we accept the null hypothesis.   *(R1)(A1)*(ft)

OR

Since

$9.17 < 9.210$, we accept the null hypothesis.   *(R1)(A1)*(ft)   *(C2)*

Notes: To award *(R1)* there should be value(s) given in part (c). If a value is given in (c), we do not need it explicitly stated again in (d).

It is sufficient to state a correct comparison.

e.g.

p-value $>$ significance level   **OR**

$\chi^2_{\text{calc}} <$ critical value

Do not award *(R0)(A1)*. Follow through from part (c).

[2 marks]

Examiners report

[N/A]

14a.   [1 mark]
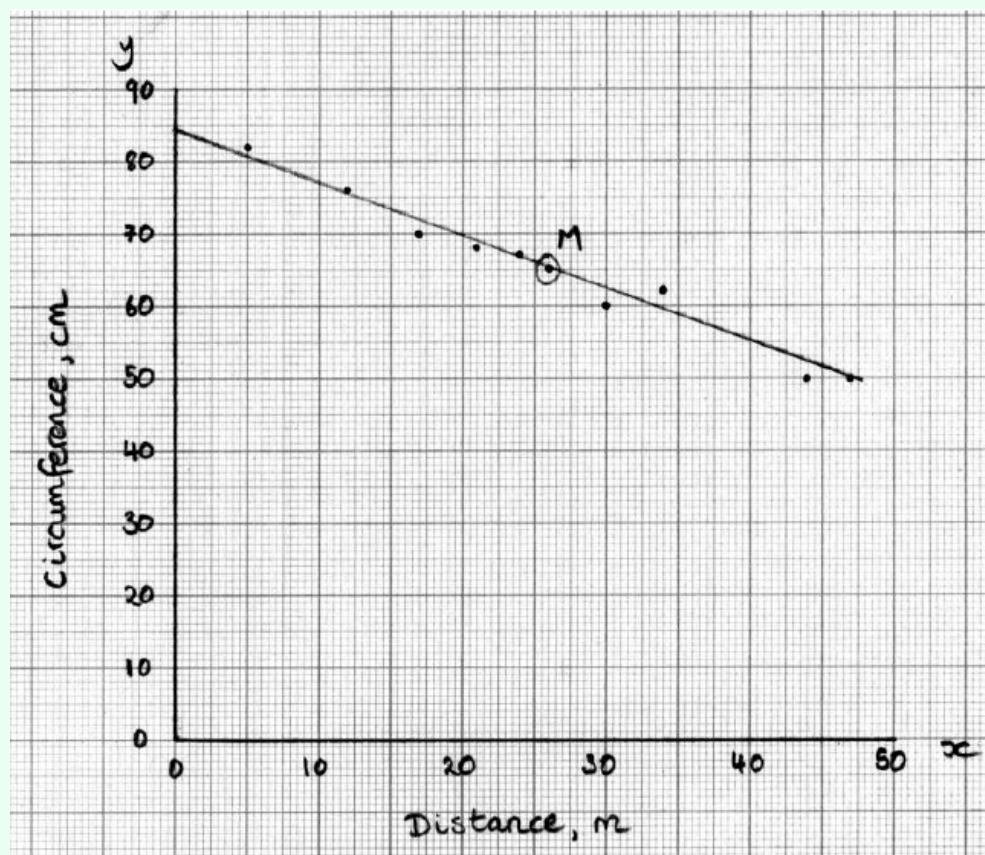
Markscheme

continuous   *(A1)*

[1 mark]

14b.

Markscheme

(A1)(A1)(A1)(A1)

Notes: Award *(A1)* for labelled axes and correct scales; if axes are reversed award *(A0)* and follow through for their points. Award *(A1)* for at least 3 correct points, *(A2)* for at least 6 correct points, *(A3)* for all 9 correct points. If scales are too small or graph paper has not been used, accuracy cannot be determined; award *(A0)*. Do not penalize if extra points are seen.

[4 marks]

14c.

Markscheme

(i)   26 (m)   *(A1)*

(ii)   65 (cm)   *(A1)*

[2 marks]

[2 marks]

Markscheme

point

M labelled, in correct position   *(A1)(A1)*(ft)

Notes: Award *(A1)*(ft) for point plotted in correct position, *(A1)* for point labelled
M or
$(\bar{x},\ \bar{y})$. Follow through from their answers to part (c).

[2 marks]

Examiners report

[N/A]

[4 marks]

Markscheme

(i)
$-0.988\ \ (-0.988432\ldots)$ *(G2)*

Note: Award *(G2)* for
-0.99. Award *(G1)* for
-0.990.
    Award *(A1)(A0)* if minus sign is omitted.

(ii)
$y = -0.756x + 84.7$
$(y = -0.756281\ldots x + 84.6633\ldots)$ *(G2)*

Notes: Award *(A1)* for
$-0.756x$, *(A1)* for
84.7. If the answer is not given as an equation, award a maximum of *(A1)(A0)*.

[4 marks]

Examiners report

[N/A]

14f.

Markscheme

regression **line** through their
M   *(A1)((ft)*
regression **line** through their
$(0, 85)$ (accept
85 ± 1)   *(A1)(ft)*

Notes: Follow through from part (d). Award a maximum of *(A1)(A0)* if the line is not straight. Do not penalize if either the line does not meet the *y*-axis or extends into quadrants other than the first.

If
M is not plotted or labelled, then follow through from part (c).

Follow through from their *y*-intercept in part (e)(ii).

[2 marks]

Examiners report

[N/A]

14g.

Markscheme

$-0.756281(40) + 84.6633$ *(M1)*
$= 54.4 \text{ (cm) } (54.4120\ldots)$ *(A1)(ft)(G2)*

Notes: Accept
54.5 (
54.46) for use of 3 sf. Accept
54.3 from use of
-0.76 and
84.7.

Follow through from their equation in part (e)(ii) **irrespective of working shown**; the final answer seen must be consistent with that equation for the final *(A1)* to be awarded.

Do not accept answers taken from the graph.

[2 marks]

Examiners report

[N/A]

15a. [2 marks]

Markscheme

 (A1)(A1)
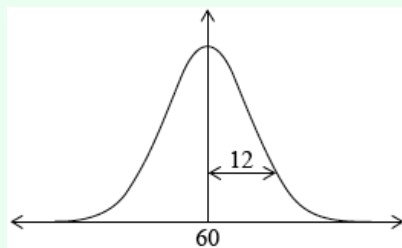
Notes: Award *(A1)* for rough sketch of normal curve centred at 60, *(A1)* for some indication of 12 as the standard deviation *eg*, as diagram, or with 72 and 48 shown on the horizontal axis in appropriate places, or for 96 and 24 shown on the horizontal axis in appropriate places.

[2 marks]

Examiners report

[N/A]

15b. [1 mark]

Markscheme

$0.5 \left(\frac{1}{2}, 50\% \right)$ *(A1)*

Note: Accept only the exact answer.

[1 mark]

Examiners report

[N/A]

15c. [2 marks]

Markscheme

0.0478 $(0.0477903...)$ *(G2)*

Note: Award *(G1)* for $0.952209...$, award *(M1)(G0)* for diagram with correct area shown but incorrect answer.

[2 marks]

Examiners report

[N/A]

[2 marks]

Markscheme

0.955 (0.955434...)   *(G2)*

Note: Award *(G1)* for
0.044565..., award *(M1)(G0)* for diagram with correct area shown but incorrect answer.

[2 marks]

Examiners report

[N/A]

[2 marks]

Markscheme

$0.0446 < 0.0478$ *(R1)*

Notes: Award *(R1)* for correct comparison seen. Accept alternative methods, for example,
1− (their answer to part (c)) used in comparison or a comparison based on
z scores.

the Physics result is better   *(A1)(ft)*

Notes: Do not award *(R0)(A1)*. Follow through from their answers to part (c) and part (d).

[2 marks]

Examiners report

[N/A]

[3 marks]

Markscheme

76   *(G3)*

Notes: Award *(G1)* for
75.8155..., award *(G2)* for
75.
   Award *(M1)(G0)* for diagram with correct area shown but incorrect answer.

[3 marks]

Examiners report

[N/A]

Markscheme
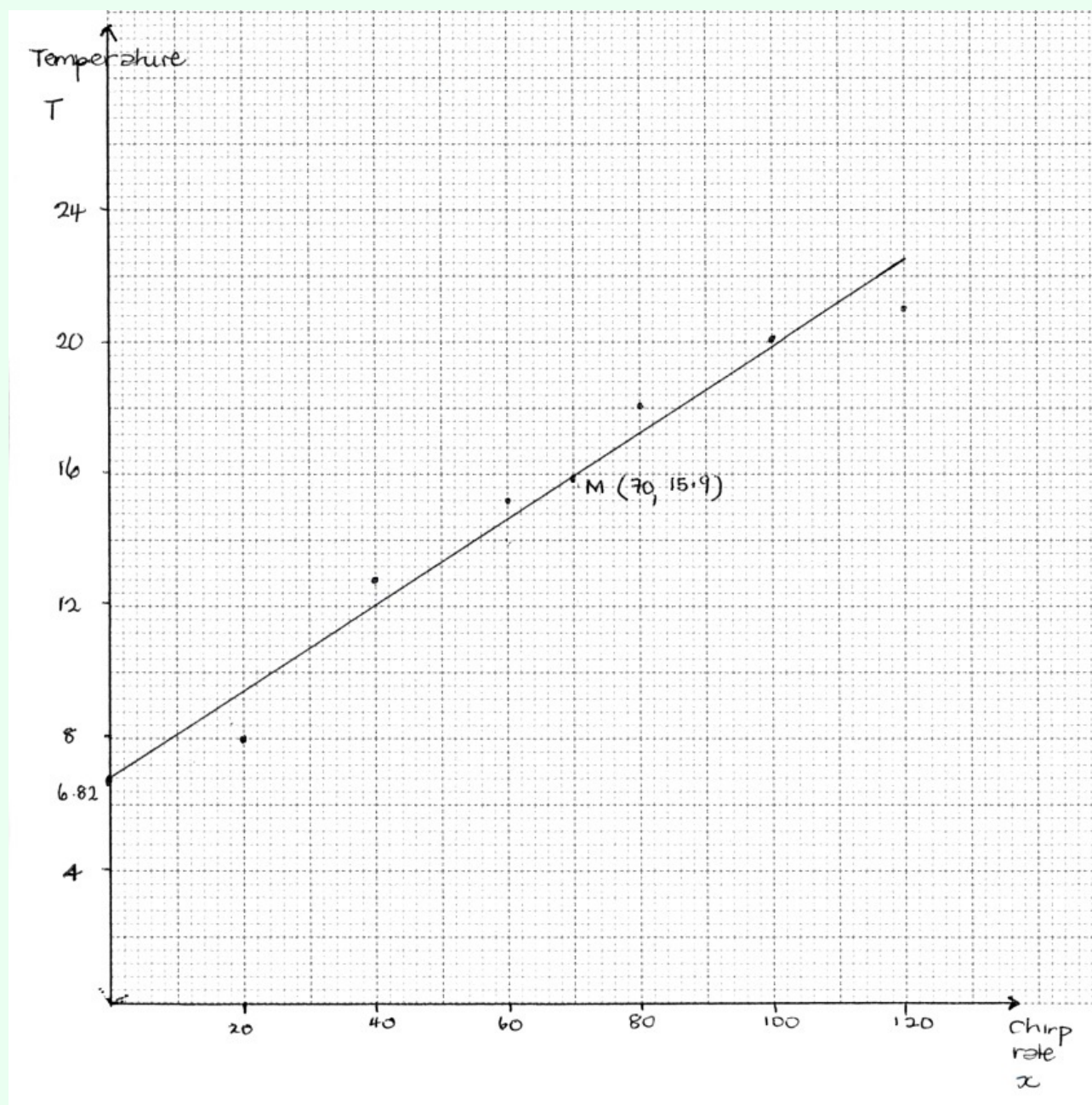
(A4)

Notes: Award *(A1)* for correct scales and labels.

Award *(A3)* for all six points correctly plotted,

(A2) for four or five points correctly plotted,

(A1) for two or three points correctly plotted.

Award at most *(A0)(A3)* if axes reversed.

Accept tolerance for T-axis.

Examiners report

[N/A]

16b.

Markscheme

0.977 $(0.977324\ldots)$ *(G2)*

Notes: Award *(G1)* for 0.97.

Examiners report

[N/A]

16c.

Markscheme

(Very) strong positive correlation *(A1)(ft)(A1)(ft)*

Notes: Award *(A1)* for (very) strong, *(A1)* for positive.

Follow through from part (b).

Examiners report

[N/A]

16d.

Markscheme

$T = 0.129x + 6.82$ *(G2)*

Notes: Award *(G1)* for $0.129x$, *(G1)* for $+6.82$.

Award a maximum of *(G0)(G1)* if the answer is not an equation.

Examiners report

[N/A]

16e.

Markscheme

$0.129 \times 70 + 6.82$ *(M1)*

Note: Award *(M1)* for substitution of 70 into their equation of regression line.

OR

$\frac{8+12.8+\ldots+21.1}{6}$ *(M1)*

$= 15.9\,(15.85)$ *(A1)(ft)(G2)*

Note: Follow through from part (d) without working.

Examiners report

[N/A]

16f. *[2 marks]*

Markscheme

regression line through $(70,\ 15.9)$ *(A1)(ft)*

Note: Accept 15.9 ± 0.2.

    Follow through from part (e).

with T-intercept, 6.82 *(A1)(ft)*

Note: Follow through from part (d). Accept 6.82 ± 0.2.

    In case the regression line is not straight (ruler not used), award *(A0)(A1)(ft)* if line passes through both their $(70,\ 15.9)$ and $(0,\ 6.82)$, otherwise award *(A0)(A0)*.

    Do not penalize if line does not intersect the T-axis.

Examiners report

[N/A]

16g. *[1 mark]*

Markscheme

$T = 0.45z + 10$ *(A1)*

Examiners report

[N/A]

16h. *[6 marks]*

Markscheme

(i) $0.45(20) + 10$ *(M1)*

Note: Award *(M1)* for correct substitution of 20 into their formula from part (g).

$= 19 \ \ (^\circ\mathrm{C})$ *(A1)(ft)(G2)*

Note: Follow through from part (g).

(ii) $= 18.2 \ \ (^\circ\mathrm{C})$ *(A1)*

(iii) $\left|\frac{19-18.2}{18.2}\right| \times 100\%$ *(M1)(A1)(ft)*

Note: Award *(M1)* for substitution in the percentage error formula, *(A1)* for correct substitution.

$4.40\% \ \ (4.39560\ldots)$ *(A1)(ft)(G2)*

Notes: Follow through from parts (h)(i) and (h)(ii).

Examiners report

[N/A]

Markscheme

$(3-1)(4-1)$ *(M1)*

$= 6$ *(A1)*   *(C2)*

[2 marks]

Examiners report

This question caused significant difficulties for many candidates. It seemed, from the responses, that the purpose of the test is not well understood, even if its procedure on the GDC can be performed.

The test is one of "independence" and it should be stressed to candidates that it is this which is key in stating the hypotheses. Improper terminology, most notably, "not correlated" is not acceptable.

Markscheme

The preferred type of drink is **independent** of age.   *(A1)*   *(C1)*

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

[1 mark]

Examiners report

This question caused significant difficulties for many candidates. It seemed, from the responses, that the purpose of the test is not well understood, even if its procedure on the GDC can be performed.

Markscheme

Reject null hypothesis as critical value
$< \chi^2_{calc}$ *(A1)(R1)*(**ft**)

Note: (**ft**) from their value in (c).

OR

Reject null hypothesis as *p*-value
< 0.05 *(A1)(R1)*   *(C2)*

Notes: Do not award *(A1)(R0)*.

Award the *(R1)* for comparison of correct values.

[2 marks]

Examiners report

This question caused significant difficulties for many candidates. It seemed, from the responses, that the purpose of the test is not well understood, even if its procedure on the GDC can be performed.

Many candidates did not know the correct figures to compare in order to arrive at the decision. Others gave no reason at all.

Markscheme

$s = 3.56\,t - 14.6$ *(A1)(A1)(A1)*   *(C3)*

Notes: Award *(A1)* for 3.56.

(A1) for –14.6.

(A1) for s and t.

[3 marks]

Examiners report

Some candidates attempted to find the equation by hand, generally without success. Those who used their calculator could quickly find the equation and use it to find the number of ice cream sales. A significant number of candidates lost one mark for writing the equation with y and x rather than s and t. A lesser number lost the accuracy mark for an integral number of ice-creams.

Markscheme

$s = 3.56 \times 24 - 14.6$ *(M1)*

$= 70.84\ (70.9)$ *(A1)***(ft)**

$= 71$ ice creams   *(A1)***(ft)**   *(C3)*

Note: (ft) from candidates answer to (a).

Note: The last *(A1)* is for specified accuracy, **(ft)** from their answer.

The *(AP)* for the paper is not applied here.

[3 marks]

Examiners report

Some candidates attempted to find the equation by hand, generally without success. Those who used their calculator could quickly find the equation and use it to find the number of ice cream sales. A significant number of candidates lost one mark for writing the equation with y and x rather than s and t. A lesser number lost the accuracy mark for an integral number of ice-creams.

Markscheme

0.965 *(A1)*   *(C1)*

[1 mark]

Examiners report

The level of accuracy required by the paper was often ignored in this question.

(a) Some candidates are unable to recover
r from a reset calculator.

19b. *[2 marks]*

Markscheme

$y = 1.15x + 0.976$ *(A1)(A1)*   *(C2)*

Note: *(A1)* for $1.15x$. *(A1)* for $+0.976$.

[2 marks]

Examiners report

The level of accuracy required by the paper was often ignored in this question.

19c. *[2 marks]*

Markscheme

$y = 1.15(7) + 0.976$ *(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)*.

[2 marks]

Examiners report

The level of accuracy required by the paper was often ignored in this question.

(c) Many candidates seem to be unaware when it is appropriate to use a regression line.

19d. *[1 mark]*

Markscheme

the correlation coefficient is close to 1

OR strongly correlated variables

OR
7 lies within the range of physics marks.   *(R1)*   *(C1)*

[1 mark]

Examiners report

The level of accuracy required by the paper was often ignored in this question.

Markscheme

(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)*

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.

[8 marks]

Examiners report

The first part of the question was relatively well done. The null hypothesis and the degrees of freedom were well answered by the majority of the students. In the show that question some students used the GDC to find the expected values table and highlighted the correct value
22.05. This procedure gained no mark; the expected value formula was expected to be used here. Also those who did use the formula were expected to show the unrounded value
22.05 to gain full marks in this part question. Many lost the answer mark for not doing so. GDC was used by most of the students to find the chi-squared test though some students attempted to find this value by hand which made them waste time. Correct values were compared when deciding whether to accept or not the null hypothesis and follow through marks were awarded from their degrees of freedom and chi-squared test when incorrect.

The second part was not as successful as the first one. Simple probability was well answered. Not all the students changed the denominator to
45 for the second probability showing their weaknesses in conditional probability. It would have been useful for the students to use a tree diagram to help them solve the last part of this question but very few did so. Some of those students that reached the last part of the question forgot to add one of the three terms. Very few used the probability of the complement.

Markscheme

(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.

[4 marks]

Examiners report

The first part of the question was relatively well done. The null hypothesis and the degrees of freedom were well answered by the majority of the students. In the show that question some students used the GDC to find the expected values table and highlighted the correct value
22.05. This procedure gained no mark; the expected value formula was expected to be used here. Also those who did use the formula were expected to show the unrounded value
22.05 to gain full marks in this part question. Many lost the answer mark for not doing so. GDC was used by most of the students to find the chi-squared test though some students attempted to find this value by hand which made them waste time. Correct values were compared when deciding whether to accept or not the null hypothesis and follow through marks were awarded from their degrees of freedom and chi-squared test when incorrect.

The second part was not as successful as the first one. Simple probability was well answered. Not all the students changed the denominator to
45 for the second probability showing their weaknesses in conditional probability. It would have been useful for the students to use a tree diagram to help them solve the last part of this question but very few did so. Some of those students that reached the last part of the question forgot to add one of the three terms. Very few used the probability of the complement.

Markscheme

(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)

$1 - \frac{102}{200} \times \frac{101}{199} = 0.741 \ (74.1\%)$ *(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

$\frac{98}{200} \times \frac{97}{199} + \frac{98}{200} \times \frac{102}{199} + \frac{102}{200} \times \frac{98}{199} = 0.741 \ (74.1\%)$ *(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.

[6 marks]

The first part of the question was relatively well done. The null hypothesis and the degrees of freedom were well answered by the majority of the students. In the show that question some students used the GDC to find the expected values table and highlighted the correct value
22.05. This procedure gained no mark; the expected value formula was expected to be used here. Also those who did use the formula were expected to show the unrounded value
22.05 to gain full marks in this part question. Many lost the answer mark for not doing so. GDC was used by most of the students to find the chi-squared test though some students attempted to find this value by hand which made them waste time. Correct values were compared when deciding whether to accept or not the null hypothesis and follow through marks were awarded from their degrees of freedom and chi-squared test when incorrect.

The second part was not as successful as the first one. Simple probability was well answered. Not all the students changed the denominator to
45 for the second probability showing their weaknesses in conditional probability. It would have been useful for the students to use a tree diagram to help them solve the last part of this question but very few did so. Some of those students that reached the last part of the question forgot to add one of the three terms. Very few used the probability of the complement.

21a. *[1 mark]*

Markscheme

Choice of music is independent of age.   *(A1)   (C1)*

[1 mark]

Examiners report

Candidates either gained good marks for this question or almost no marks depending on their preparation. It was obvious that some schools had omitted this from their programme. Candidates generally gave a reason for their conclusion in part (d) though some compared the chi-squared value with the
p-value, resulting in the loss of both marks.

21b. *[1 mark]*

Markscheme

$(3-1)(3-1)$

$=4$ *(A1)   (C1)*

[1 mark]

Examiners report

Candidates either gained good marks for this question or almost no marks depending on their preparation. It was obvious that some schools had omitted this from their programme. Candidates generally gave a reason for their conclusion in part (d) though some compared the chi-squared value with the
p-value, resulting in the loss of both marks.

21c. *[2 marks]*

Markscheme

$\chi^2 = 51.6$ *(A2)   (C2)*

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

[2 marks]

21d. [2 marks]

Markscheme

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

or
$51.6 > \chi^2{}_{crit}$

Reject the null hypothesis *(do not accept the null hypothesis).*   *(A1)(ft)*   *(C2)*

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

[2 marks]

Examiners report

Candidates either gained good marks for this question or almost no marks depending on their preparation. It was obvious that some schools had omitted this from their programme. Candidates generally gave a reason for their conclusion in part (d) though some compared the chi-squared value with the
p-value, resulting in the loss of both marks.

22a. [2 marks]

Markscheme

(i)   19.2   *(G1)*

(ii)   1.45   *(G1)*

[2 marks]

Examiners report

(i)   Generally well done but many lost an AP here

(ii)   Only correct if the candidate knew how to use their GDC and even then several gave the wrong standard deviation.

22b. [1 mark]

Markscheme

$r = 0.942$ *(G1)*

[1 mark]

Examiners report

Again, only correct if the candidate could use their GDC. Many answers given were greater than 1 and the candidates did not see anything wrong with this.

Markscheme

Strong, positive correlation.   *(A1)(ft)(A1)(ft)*

[2 marks]

Examiners report

Many received a ft mark for this part. The word "positive" was often omitted.

Markscheme

(i)
$d = 11.5$ *(G1)*

(ii)
$n = 11.5 \times 19.6 - 100$

$= 125$ (*accept*
126)   *(A1)(ft)*

Note: Answer must be a whole number.

[2 marks]

Examiners report

(i)   Most candidates substituted the first set of points into the equation instead of finding the regression line on their GDC.

(ii)   Most managed to score a ft point here. But some did not give their answer as a whole number.

Markscheme

It is unreliable to extrapolate outside the values given (outlier).   *(R1)*

[1 mark]

Examiners report

Not many candidates mentioned the idea of an outlier. Most came up with some creative reason, albeit wrong, as to why the answer might be unreliable. Some of them made interesting reading.

Markscheme

(i)
$\frac{280}{400}$ (0.7, 70% or equivalent)   *(A1)(A1)(G2)*

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

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

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

[4 marks]

23b. *[3 marks]*

Markscheme

$\frac{180}{400} \times \frac{179}{399}$ *(A1)(M1)*

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

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

[3 marks]

23c. *[1 mark]*

Markscheme

H_0 : 'the preference of brand of cereal is independent of the city'.   *(A1)*

OR

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

[1 mark]

23d. *[1 mark]*

Markscheme

$df = 2$ *(A1)*

[1 mark]

23e.

[2 marks]

Markscheme

$\frac{210 \times 120}{400}$ *(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.

[2 marks]

Examiners report

Candidates answered part (a) correctly. Some lost one out of the 4 marks for making an error in the denominator of the conditional probability. In (b) many students failed to see that (b) was 'without replacement'. Parts (c), (d) and (e) seemed to be very well done by some centres and uniformly badly by others. In (e) many gave the table from the GDC and highlighted the value 63 for which no mark was gained. Expected value formula should have been used instead.

23f.

[2 marks]

Markscheme

39.3   *(G2)*

Note: Award *(G1)(A0)(AP)* if answers not to 3 significant figures.

[2 marks]

Examiners report

Candidates answered part (a) correctly. Some lost one out of the 4 marks for making an error in the denominator of the conditional probability. In (b) many students failed to see that (b) was 'without replacement'. Parts (c), (d) and (e) seemed to be very well done by some centres and uniformly badly by others. In (e) many gave the table from the GDC and highlighted the value 63 for which no mark was gained. Expected value formula should have been used instead.

23g.

[2 marks]

Markscheme

$p - \text{value} < 0.05$ *(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.
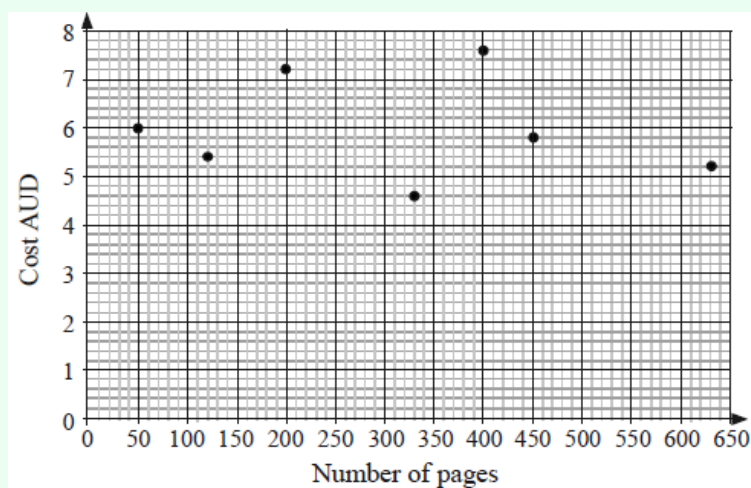
[2 marks]

Examiners report

Candidates answered part (a) correctly. Some lost one out of the 4 marks for making an error in the denominator of the conditional probability. In (b) many students failed to see that (b) was 'without replacement'. Parts (c), (d) and (e) seemed to be very well done by some centres and uniformly badly by others. In (e) many gave the table from the GDC and highlighted the value 63 for which no mark was gained. Expected value formula should have been used instead.

Markscheme

(A1)(A1)(A1)

Notes: *(A1)* for label and scales, *(A2)* for all points correct, *(A1)* for 5 or 6 correct. Award a maximum of *(A2)* if points are joined.

[3 marks]

Examiners report

The graph was well done with almost all candidates labelling and scaling the axes correctly. A minority of students joined the points or drew the graph on lined paper which prevented them from gaining full marks in this part of the question.

In (b) some candidates were not able to calculate the linear correlation coefficient. A few G2 comments pointed out that the command term used may have been ambiguous to some candidates and they did not think that they could use their GDC to find r. Some attempted to use the formula even though the value of
S_{xy} was not given. The guide says that 'A GDC can be used to calculate r when raw data is given'. This potential unfairness was taken into consideration during the setting of boundaries so that no candidate was disadvantaged by the possible ambiguous wording of the question. In future the command term 'Using your GDC' or 'Write down' will be used in similar questions.

Some students who did use the GDC gave
r^2 instead of
r. This really caught the attention of many examiners as
r^2 is not in the syllabus.

Markscheme

$r = -0.141$ *(G2)*

Note: If negative sign is missing award *(G1)(G0)*.

[2 marks]

Examiners report

The graph was well done with almost all candidates labelling and scaling the axes correctly. A minority of students joined the points or drew the graph on lined paper which prevented them from gaining full marks in this part of the question.

In (b) some candidates were not able to calculate the linear correlation coefficient. A few G2 comments pointed out that the command term used may have been ambiguous to some candidates and they did not think that they could use their GDC to find r. Some attempted to use the formula even though the value of
S_{xy} was not given. The guide says that 'A GDC can be used to calculate r when raw data is given'. This potential unfairness was taken into consideration during the setting of boundaries so that no candidate was disadvantaged by the possible ambiguous wording of the question. In future the command term 'Using your GDC' or 'Write down' will be used in similar questions.

Some students who did use the GDC gave
r^2 instead of
r. This really caught the attention of many examiners as
r^2 is not in the syllabus.

Markscheme

'The coefficient of correlation is too low, (very) weak (linear) relationship'.   *(R1)*

Not a sensible thing to do, *accept 'no'.*   *(A1)*

Note: Do not award *(R0)(A1)*. The correlation coefficient has to be mentioned in their reasoning.

[2 marks]

Examiners report

The graph was well done with almost all candidates labelling and scaling the axes correctly. A minority of students joined the points or drew the graph on lined paper which prevented them from gaining full marks in this part of the question.

In (b) some candidates were not able to calculate the linear correlation coefficient. A few G2 comments pointed out that the command term used may have been ambiguous to some candidates and they did not think that they could use their GDC to find r. Some attempted to use the formula even though the value of S_{xy} was not given. The guide says that 'A GDC can be used to calculate r when raw data is given'. This potential unfairness was taken into consideration during the setting of boundaries so that no candidate was disadvantaged by the possible ambiguous wording of the question. In future the command term 'Using your GDC' or 'Write down' will be used in similar questions.

Some students who did use the GDC gave r^2 instead of r. This really caught the attention of many examiners as r^2 is not in the syllabus.