# Mark Scheme (Results)

## Summer 2013

## GCE Statistics 1 (6683/01R)

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## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

# EDEXCEL GCE MATHEMATICS

## General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes:

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- $*$ The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark
  ⌙

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

8. In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme

| Question | Scheme | Marks |
|---|---|---|
| **1. (a)** | $b = \frac{18.35}{312.1}[= 0.058795...]$ | M1 |
| | $a = 5.8 - "0.058795..." \times 4.8$ | M1 |
| | **$\underline{a}$ = awrt 5.52** | A1 |
| | So **$\underline{y = 5.52 + 0.0588x}$** | A1 (4) |
| **(b)** | $\frac{e}{10} = "5.52" + "0.0588" \times \left(\frac{g-60}{4}\right)$ | M1 |
| | $4e = 220.71 + 0.588(g - 60)$ | dM1 |
| | **$\underline{e = 46 + 0.15g}$** | A1A1 (4) |
| **(c)** | $e = "46" + "0.15" \times 100$ | M1 |
| | **= $\underline{61}$** | A1 (2) |
| | | **[10]** |

| | Notes |
|---|---|
| **(a)** | 1st M1 for a correct expression for $b$<br>2nd M1 for a correct expression for $a$ – ft their value of $b$<br>1st A1 for $a$ = awrt 5.52<br>2nd A1 for a correct equation in $y$ and $x$ with $a$ and $b$ correct to awrt 3 sf |
| **(b)** | 1st M1 for substitutions into <u>their</u> equation to get an equation in $e$ and $g$.<br>Need $y = \frac{e}{10}$ and $x = \frac{g-60}{4}$<br>2nd dM1 Dep. on 1st M1 for an attempt to simplify (at least removing fractions). Allow one slip<br>1st A1 for an equation $e$ = awrt 46 $\pm$ …..<br>2nd A1 for an equation $e$ = ….+ awrt 0.15$g$ |
| **ALT** | 1st M1 for use of $d = \frac{10 \times "\text{their } b"}{4}$ or sight of 0.15 used as gradient<br>2nd dM1 Dep. on 1st M1 for use of $\overline{e} = 10 \times "\text{their } \overline{y}"$ or sight of 58 and use of $\overline{g} = 4 \times "\text{their } \overline{x}" + 60$ or sight of 79.2 and use of these values to find $c$ in $c = \overline{e} - d\overline{g}$ |
| **(c)** | M1 for substituting $g$ = 100 into their new equation (or $x$ = 10 and then attempting to × ans.by 10)<br>A1 for awrt 61 |

| Question | Scheme | Marks |
|---|---|---|
| **2. (a)** | <table><tr><td>$x$</td><td>**1**</td><td>**2**</td><td>**3**</td></tr><tr><td>$P(X = x)$</td><td>**<u>0.4</u>**</td><td>0.25</td><td>0.35</td></tr></table> | |
| | $P(X = 2) = F(2) - F(1)$ (o.e.) | M1 |
| | $P(X = 2) =$ **<u>0.25</u>** | A1 |
| | $P(X = 3) =$ **<u>0.35</u>** | A1 (3) |
| **(b)** | [$F(1.8) = P(X \leq 1.8) = P(X \leq 1) =$ ] **<u>0.4</u>** | B1 (1) |
| | | **[4]** |
| | **Notes** | |
| **(a)** | M1 for $P(X = 1) = 0.4$ **and** evidence of a correct method for finding $P(X = 2)$ or $P(X = 3)$. Implied by correct ans.<br>1st A1 for $P(X = 2) = 0.25$<br>2nd A1 for $P(X = 3) = 0.35$ | |
| **(b)** | B1 for 0.4 | |

| Question | Scheme | Marks |
|---|---|---|
| **3. (a)** | Width = $2\times1.5$ = **3 (cm)** | B1 |
| | Area = $8\times1.5=12$ cm$^2$ Frequency = 24 so 1 cm$^2$ = 2 plants (o.e.) | M1 |
| | Frequency of 12 corresponds to area of 6 so height = **2 (cm)** | A1 (3) |
| **(b)** | $[Q_2 =]\ (5+)\ \frac{19}{24}\times5$ **or** (use of $(n+1)$) $(5+)\frac{19.5}{24}\times5$ | M1 |
| | = 8.9583… **awrt 8.96** **or** 9.0625… awrt 9.06 | A1 (2) |
| **(c)** | $[\bar{x} =]\ \frac{755}{70}$ or **awrt 10.8** | B1 |
| | $[\sigma_x =]\ \sqrt{\frac{12037.5}{70}-\bar{x}^2}$ = $\sqrt{55.6326...}$ | M1A1ft |
| | = **awrt 7.46** (Accept $s$ = awrt 7.51) | A1 (4) |
| **(d)** | $\bar{x} > Q_2$ | B1ft |
| | So positive skew | dB1 (2) |
| **(e)** | $\bar{x}+\sigma \approx 18.3$ so number of plants is e.g. $\frac{(25-"18.3")}{10}\times12\ (+4)$ (o.e.) | M1 |
| | = 12.04 so **12** plants | A1 (2) |
| | | **[13]** |

| | Notes |
|---|---|
| **(a)** | M1 for forming a relationship between area and no. of plants or their width × their height = 6<br>A1 for height of 2 (cm). Make sure the 2 refers to height and not plants! |
| **(b)** | M1 for a suitable fraction ×5 (ignore end points)<br>A1 for awrt 8.96 (or $\frac{215}{24}$ or $8\frac{23}{24}$) or 9.06 ( or $\frac{145}{16}$ or $9\frac{1}{16}$ ) if using ($n$ + 1) |
| **(c)** | B1 for a correct mean. Accept exact fraction or awrt 10.8<br>M1 for a correct expression for $\sigma$ or $\sigma^2$. Condone mixed up labelling- ft their mean<br>A1ft for a correct expression – ft their mean but must have square root<br>A1 for awrt 7.46 (use of $s$ = awrt 7.51). Condone correct working and answer called variance. |
| **(d)** | 1st B1ft for a correct comparison of their $\bar{x}$ and their $Q_2$ |
| **ALT** | Allow use of a formula for skewness that involves $(\bar{x}-Q_2)$ or use of quartiles but must have correct values<br>NB $Q_1 = 5.31,\ Q_3 = 14.46$ (awrt 14.5), $Q_3 - Q_2 \approx 5.5,\ Q_2 - Q_1 \approx 3.7 / 6$<br>2nd dB1 Dependent on a suitable reason for concluding "positive skew" . "correlation" is B0 |
| **(e)** | M1 for a suitable expression involving some interpolation (condone missing 4 so accept awrt 8)<br>Condone use of end points of 25.5 and 14.5 in their interpolation expressions.<br>A1 for 12 (condone awrt 12). Answer only 2/2 |

| Question | Scheme | Marks |
|---|---|---|
| **4. (a)** | $\left[\mathrm{P}(M<145)=\right]\ \mathrm{P}\left(Z<\frac{145-150}{10}\right)$ | M1 |
| | $=\mathrm{P}(Z<-0.5)$ or $\mathrm{P}(Z>0.5)$ | A1 |
| | = **awrt <u>0.309</u>** | A1 (3) |
| **(b)** | $\left[\mathrm{P}(B>115)=0.15\Rightarrow\right]\ \frac{115-100}{d}=1.0364$ (Calc gives 1.036433...) | M1B1A1 |
| | ***<u>d = 14.5</u>*** (Calc gives 14.4727...) | A1 (4) |
| **(c)** | $[\mathrm{P}(X>\mu+15 \mid X>\mu-15)=]\ \frac{\mathrm{P}(X>\mu+15)}{\mathrm{P}(X>\mu-15)}$ | M1 |
| | $=\frac{0.35}{1-0.35}$ | A1 |
| | $=\frac{7}{13}$ or **<u>awrt 0.538</u>** | A1 (3) |
| | | **[10]** |

| | Notes |
|---|---|
| | **Condone poor use of notation if a correct line appears later.** |
| **(a)** | M1 for standardising with 145, 150 and 10. Allow $\pm$ and use of symmetry so 155 instead of 145<br>1st A1 for $\mathrm{P}(Z<-0.5)$ or $\mathrm{P}(Z>0.5)$ i.e. a $z$ value of $\pm$ 0.5 and a correct region indicated<br>2nd A1 for awrt 0.309 Answer only is 3/3 |
| **(b)** | M1 for $\pm\frac{115-100}{d}=z$ where $\lvert z\rvert>1$ Condone MR of $\mu=150$ instead of 100 for M1B1only<br>B1 for a standardised expression = $\pm$ 1.0364 (do not allow for use of 1 – 1.0364)<br>1st A1 for $z$ = awrt 1.04 and compatible signs i.e. a correct equation with $z$ = awrt 1.04<br>2nd A1 for awrt 14.5 (allow awrt 14.4 if $z$ = awrt 1.04 is seen) |
| **Calc** | Answer only of awrt 14.473 scores M1B1A1A1<br>Answer only of awrt 14.48 scores M1B0A1A1 |
| **(c)** | M1 for a correct ratio expression need $\mathrm{P}(X>\mu+15)$ on numerator. Allow use of a value for $\mu$ May be implied by next line.<br>NB $\frac{0.35\times0.65}{0.65}=\frac{0.2275}{0.65}$ is M0<br>1st A1 for a correct ratio of probabilities<br>2nd A1 for awrt 0.538 or $\frac{7}{13}$ (o.e.). Allow 0.5385 provided 2nd A1 is scored. |

| Question | Scheme | Marks |
|---|---|---|
| **5. (a)** | $S_{yy} = 393 - \frac{61^2}{10}$ = **<u>20.9</u>** | M1A1 |
| | $S_{xy} = 382 - \frac{61\times 60}{10}$ = **<u>16</u>** | A1 (3) |
| **(b)** | $[r =]\frac{"16"}{\sqrt{"20.9"\times 28}}$ | M1 |
| | = 0.66140… **<u>awrt 0.661</u>** | A1 (2) |
| **(c)** | Researcher's belief suggests <u>negative</u> correlation, data suggests <u>positive</u> correlation | B1 |
| | So data does <u>not</u> support researcher's belief | dB1 (2) |
| **(d)** | New $x$ equals $\bar{x} = 6$ | B1 |
| | Since $S_{xx} = \sum(x-\bar{x})^2$ the value of $S_{xx}$ is the same = 28 | dB1 (2) |
| **(e)** | $S_{xy} = \sum(x-\bar{x})(y-\bar{y}) = \sum(x-\bar{x})y$ so the new term will be zero (since mean = $x$) and since $S_{yy}$ increases | B1 |
| | So $r$ will decrease | dB1 (2) **[11]** |

| | Notes |
|---|---|
| **(a)** | M1 for a correct expression for $S_{yy}$ or $S_{xy}$<br>1st A1 for $S_{yy}$ = 20.9<br>2nd A1 for $S_{xy}$ = 16 |
| **(b)** | M1 for a correct expression for $r$ – ft their 20.9 (provided it is > 0) and their 16.<br>Use of 382 for 16 or 393 for 20.9 is M0<br>A1 for awrt 0.661 |
| **(c)** | 1st B1 for a suitable reason <u>contrasting</u> belief with data. They must state the sign (positive or negative) of the correlation of data or the belief and imply the other is opposite<br>2nd dB1 Dependent on a correct reason for saying it does <u>not</u> support the claim<br>e.g. State "does not support the belief because data has positive correlation" scores B1B1 BUT<br>State "does support the belief because data has positive correlation" scores B0B0 |
| **(d)** | 1st B1 for clearly stating that new value of $x$ = (6 =) mean<br>2nd dB1 Dep. on 1st B1 for a reason that shows $S_{xx}$ is unchanged e.g. extra term is 0 so $S_{xx}$ is the same |
| **ALT** | 1st B1 for seeing $\sum x = 66$ and new $\sum x^2 = 424$ (or $388 + 6^2$) and attempt at $S_{xx}$<br>2nd B1 for showing $S_{xx} = 28$ with $n = 11$ and no incorrect working seen and a final comment |
| **(e)** | 1st B1 for a clear reason that mentions $S_{xy}$ is the same <u>and</u> the increase in $S_{yy}$<br>Saying that $r$ increases or stays the same is B0B0<br>2nd dB1 Dependent on 1st B1 for saying $r$ will decrease. |

| Question | Scheme | Marks |
|---|---|---|
| **6. (a)** | [P($B$) = 0.4, P($A$) = $p$ + 0.1 so] $0.4\times(p+0.1)=0.1$ or $0.4\times\text{P}(A)=0.1$ | M1 |
| | $p=\frac{1}{4}-0.1$ **$\underline{p = 0.15}$** | M1A1 (3) |
| **(b)** | $\frac{5}{11}=\left[\frac{\text{P}(B\cap C)}{\text{P}(C)}=\right]\frac{0.2}{0.2+q}$ or $\frac{5}{11}=\frac{0.2}{\text{P}(C)}$ | M1 |
| | $11\times0.2=5\times(0.2+q)$ | dM1 |
| | **$\underline{q = 0.24}$** | A1 |
| | $r$ = 0.6 – ($p$ + $q$) i.e. **$\underline{r = 0.21}$** | A1ft (4) |
| **(c)** | $\left[\frac{\text{P}((A\cup C)\cap B)}{\text{P}(B)}\right]=\frac{0.3}{0.4}$ | M1 |
| | = **$\underline{0.75}$** | A1 (2) |
| | | **[9]** |

| | Notes |
|---|---|
| **(a)** | 1st M1 for using independence in an attempt to form an equation in $p$ or P($A$)<br>2nd M1 for a correct attempt to solve their linear equation leading to $p$ = …<br>A1 for 0.15 or exact equivalent |
| **(b)** | 1st M1 for a clear attempt to use P($B$\|$C$) to form an equation for $q$ or P($C$). Assuming indep M0<br>2nd dM1 Dep. on 1st M1 for correctly simplifying to a linear equation in $q$ or P($C$)<br>e.g. accept $11\times0.2=5\times0.2+q$ or 5P($C$) = 2.2<br>1st A1 for $q$ = 0.24 or exact equivalent<br>2nd A1ft for 0.6 – their ($p$ + $q$) Dependent on 1st M1 in (b) only. |
| **(c)** | M1 for a correct ratio expression and one correct value (num < denom) <u>or</u> a fully correct ratio.<br>Allow $\frac{\text{P}(A\cup C\cap B)}{\text{P}(B)}$ with one probability correct but only if num < denom.<br>A numerator of $\text{P}(A\cup C)\times\text{P}(B)$ scores M0<br>A1 for 0.75 or an exact equivalent |

| Question | Scheme | Marks |
|---|---|---|
| **7. (a)** | $E(S) = 0+1\times0.2+2\times0.1+4\times0.3+5\times0.2$ = [0.2 + 0.2 + 1.2 + 1.0]<br>**2.6** | M1<br>A1 (2) |
| **(b)** | $E(S^2) = 0+1\times0.2+2^2\times0.1+4^2\times0.3+5^2\times0.2$ or 0.2 + 0.4 + 4.8 + 5<br>**10.4 (*)** | M1<br>A1cso (2) |
| **(c)** | $\text{Var}(S) = 10.4-(\text{"2.6"})^2$<br>**3.64** or $\frac{91}{25}$ (o.e.) | M1<br>A1 (2) |
| **(d)(i)** | $5E(S) - 3 = 5\times$"2.6" $- 3$, = **10** | M1, A1 |
| **(ii)** | $5^2\text{Var}(S) = 25\times3.64$, = **91** | M1, A1 (4) |
| **(e)** | $5S-3>S+3 \Rightarrow 4S>6$ or $S > 1.5$, so need $P(S \geq 2)$<br>$P(S \geq 2)$ = **0.6** | M1, A1<br>A1 (3) |
| **(f)** | $P(S_1=1)\times P(S_2\leq 4), = 0.2\times0.8 = 0.16$ **(*)** | M1,A1cso(2) |
| **(g)** | $P(S_1=2)\times P(S_2\leq 2) = 0.1\times0.5 = 0.05$<br>$P(S_1=4)\times P(S_2\leq 1) = 0.3\times0.4 = 0.12$<br>$P(S_1=5)\times P(S_2=0) = 0.2\times0.2 = 0.04$<br>$P(S_1=0)\times P(S_2=\text{any value}) = 0.2\times1 = 0.20$<br>Full method – all cases listed<br>all correct products<br>= **0.57** | M1<br>A1<br>A1 (3)<br>**[18]** |

| | Notes |
|---|---|
| **(a)** | M1 for an attempt at $\sum xP(X=x)$, at least 2 non-zero terms seen. Correct answer 2/2<br>A1 for 2.6 or any exact equivalent |
| **(b)** | M1 for a correct attempt, at least 3 non-zero terms seen<br>A1cso for 10.4 provided M1 is scored and no incorrect working seen |
| **(c)** | M1 for $10.4-\mu^2$, ft their $\mu$. Must see their value of $\mu$ squared (A1 for 3.64 or any exact equiv.) |
| **(d)(i)** | M1 for a correct expression using their 2.6 (A1 for 10) |
| **(ii)** | M1 for $25\times\text{Var}(S)$- ft their Var($S$) (A1 for 91) |
| **(e)** | M1 for solving the inequality as far as $pS > q$ where one of $p$ or $q$ are correct<br>1st A1 for $P(S \geq 2)$<br>2nd A1 for 0.6 (provided $S > 1.5$ was obtained). Ans only of 0.6 scores 3/3 |
| **(f)** | **A table showing all 25 cases can only score M1 in (*g*) if the correct cases are indicated.**<br>M1 for using independence (so multiplying) and attempting $P(S_2 \leq 4)$<br>e.g. $0.2\times(0.2+0.2+0.1+0.3)$ or 0.04+0.04+0.02+0.06 score M1 BUT $\frac{4}{25}$ (not from $0.2\times0.8$) is M0A0<br>A1cso for a fully correct explanation leading to 0.16. Must come from $0.2\times0.8$ not $\frac{4}{25}$ |
| **(g)** | M1 for all cases for $S_1$ or all 15 cases for $X$<br>1st A1 for all correct probability products for $S_1$ or $X$<br>2nd A1 for 0.57 Correct answer scores 3/3. Probabilities out of 25 score A0A0 |

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