# Mark Scheme (Results)

## Summer 2014

## Pearson Edexcel International A Level in Statistics 1
## (WST01/01)

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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 IAL 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
- $\lfloor$ 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. Ignore wrong working or incorrect statements following a correct answer.

| Question | Scheme | Marks |
|---|---|---|
| **1. (a)** | $S_{yy} = 39418 - \frac{560^2}{8}$ | M1 |
| | $= \mathbf{\underline{218}}$ | A1cao (2) |
| **(b)** | $[r =] \frac{-710}{\sqrt{"218" \times 2587.5}}$ | M1 |
| | $= -0.945344...$ **awrt** $\underline{-0.945}$ | A1 (2) |
| **(c)** | As <u>age</u> <u>increases</u>, <u>volume/blood</u> (pumped) <u>decreases</u> (o.e.) | B1 (1) |
| **(d)** | **Yes** as $r$ is close to **–** 1 (if $r < -0.5$) <u>or</u> **Yes** as $r$ is close to 1 (if $r > 0.5$)<br>For ft, if $-0.5 \leq r \leq 0.5$ "**No** since $r$ is close to 0" | B1ft (1) |
| **(e)** | $b = \frac{-710}{2587.5} = -0.27439...$ $\left(\text{allow } \frac{-284}{1035}\right)$ awrt **–** 0.27 | M1 A1 |
| | $a = \frac{560}{8} - "\text{their } b" \times \frac{370}{8} [= 82.690...]$ so **$\underline{y = 82.7 - 0.274x}$** | M1, A1 (4) |
| **(f)(i)** | ($y$ = 82.7 – 0.274 ×40 =) 71.74.. = awrt **<u>72</u>** | B1 |
| **(ii)** | Should be reliable since interpolation (o.e.) | B1 (2) |
| | | **[12]** |

| | Notes |
|---|---|
| **(a)** | M1 for a correct expression for $S_{yy}$<br>A1 for 218 (condone 218.0) |
| **(b)** | M1 for attempt at correct formula with their $S_{yy}$ (>0) and given $S_{xx}$ , $S_{xy}$ in the correct places<br>Condone missing "–" for M1<br>$-0.95$ with no expression seen scores M1A0, awrt – 0.945 with no working scores M1A1 |
| **(c)** | B1 Must mention "age" and "volume" or "blood (pumped)" No ft. |
| **(d)** | B1ft must comment on supporting **and** state: <u>high/strong/clear</u> (negative or positive) <u>correlation</u><br>'points lie close to a line' is B0 since there is no evidence of this.<br>Do not follow through $\lvert r \rvert > 1$. |
| **(e)** | 1st M1 for a correct expression for $b$. Condone missing "–"<br>1st A1 for awrt $-0.27$ or allow exact fraction.<br>2nd M1 for a correct method for $a$. Follow through their value of $b$<br>2nd A1 for a correct equation for $y$ and $x$ with $a$ = awrt 82.7 and $b$ = awrt $-0.274$ <u>No fractions</u> |
| **(f)** | 1st B1 for awrt 72<br>2nd B1 for a comment that suggests it <u>is</u> reliable since 40 is within the range of the ages/$x$-values of the data <u>or</u> interpolation<br>NB "it is reliable since it is in the range" is B0 since "it" is not explicit enough<br>Condone extra non-relevant comments but penalise contradictory comments.<br>e.g. "reliable since 40 is within the range (of ages) <u>and 72 within range of volumes</u>" is B1 since <u>irrelevant</u> |

| Question | Scheme | Marks |
|---|---|---|
| **2. (a)** | Width = $\frac{5}{3}\times 1.5$ = **<u>2.5 (cm)</u>** | B1 |
| | Area = $6\times 1.5 = 9$ cm$^2$ has frequency = 12 so 1.5 cm$^2$ = 2 people (o.e.) | M1 |
| | Frequency of 10 corresponds to area of 7.5 so height = **<u>3 (cm)</u>** | A1 (3) |
| **(b)** | $Q_2 = [2.5+]\frac{(25/25.5-16)}{12}\times 3 = 4.75$ (or 4.875 if use $n+1$) awrt **<u>4.75</u>** | M1 A1 (2) |
| **(c)(i)** | $[\bar{x} =]\ \frac{394}{50} = 7.88$ **(*)** | B1cso |
| **(ii)** | $[\sigma_x =]\ \sqrt{\frac{6500}{50}-\bar{x}^2}\ = \sqrt{67.9056}$ | M1A1 |
| | = **<u>awrt 8.24</u>** (Accept $s$ = awrt 8.32) | A1 (4) |
| **(d)** | $\bar{x} > Q_2$ | B1ft |
| | So <u>positive</u> (skew) | dB1 (2) |
| **(e) (i)** | There is <u>no effect</u> on the mean | B1 |
| **(ii)** | The median will <u>increase</u> | B1 |
| **(iii)** | The standard deviation will <u>decrease</u> | B1 (3) |
| | | **[14]** |

**Notes**

**(a)**
M1 for forming a relationship between area and no. of people <u>or</u> "their width" × "their height"= 7.5
<u>or</u> for $\frac{3h}{10}=\frac{9}{12}$ oe
A1 for height of 3 (cm)
NOTE: the common incorrect answer width = 3 and height = 2.5 scores B0M1A0

**(b)**
M1 for a correct fraction$\left[\frac{9}{12}\right.$ or $\left.\frac{9.5}{12}\right]\times 3$. Ignore end point but must be +.
May be seen in an equivalent expression e.g. $\frac{(x-2.5)}{5.5-2.5}=\frac{25-16}{28-16}$
Allow use of $(n+1)$ giving 4.875
NB May work down so look out for $[5.5]-\frac{28-25}{12}\times 3$, etc.

**(c)(i)**
B1 for $\frac{394}{50}$ or for fully correct expression seen $\frac{16\times 1.25+12\times 4+10\times 8+8\times 15.5+4\times 30.5}{50}$

**(ii)**
M1 for a correct expression must have 6500, 50 and 7.88. (square root not necessary for M1)
1st A1 for a correct expression which must have square root
2nd A1 for awrt 8.24 (use of $s$ = awrt 8.32). Condone incorrect labelling if awrt 8.24 is found.

**(d)**
1st B1ft for a correct comparison of $\bar{x}$ =7.88 and their $Q_2$ (this may be seen embedded in another formula i.e. 3(mean-median)/s.d.)
$Q_3-Q_2 > Q_2-Q_1$ is B0 unless $Q_1$ and $Q_3$ have been found. ($Q_1 = 1.95/1.99$, $Q_3 = 10.25/10.81$)
2nd dB1 Dependent on the 1st B1 and for concluding "positive" skew.
Note: if their $Q_2$ >7.88, then B0. Positive correlation is B0.

| Question | Scheme | Marks |
|---|---|---|
| **3. (a)** | $P(X = 1) = F(1) = \mathbf{\underline{0.2}}$ | B1 |
| | e.g. $P(X = 3) = F(3) - F(1) = \mathbf{\underline{0.3}}$ | M1 |
| | $x$ \| 1 \| 3 \| 5 \| 7 <br> $P(X = x)$ \| 0.2 \| 0.3 \| **0.4** \| **0.1** | A1 A1 |
| | | (4) |
| **(b)** | $P(2 < X \leq 6) = P(X = 3) + P(X = 5)$ | M1 |
| | $= \mathbf{0.7}$ | A1 |
| | | (2) |
| **(c)** | $F(4) = P(X \leq 4) = P(X \leq 3) = F(3) = \mathbf{0.5}$ | B1 |
| | | (1) |
| | | **[7]** |

| | Notes |
|---|---|
| **(a)** | B1 for $P(X = 1) = 0.2$ or $P(1) = 0.2$ |
| | M1 for a correct method using $F(x)$ to find one other probability (may be implied by one other correct probability) |
| | 1st A1 for any two correct probabilities from $P(X = 3) = 0.3$, $P(X = 5) = 0.4$, $P(X = 7) = 0.1$ |
| | 2nd A1 for a fully correct probability distribution. |
| | For both A marks, condone missing/incorrect labels, but the probabilities must be associated with the correct $x$-values |
| **(b)** | M1 for $P(X = 3) + P(X = 5)$ (may ft their values) or $F(5) - F(1)$ |
| | A1 for 0.7 oe |
| **(c)** | B1 for 0.5 oe |

| Question | Scheme | Marks |
|---|---|---|
| **4. (a)** | $P(Y > 17) = 1 - P(Y < 17) = \mathbf{0.4}$ | B1 (1) |
| **(b)** | $P(Y < \mu) = 0.5$ or $[P(\mu < Y < 17) =] \ 0.6 - 0.5$ | M1 |
| | $= \mathbf{0.1}$ | A1 (2) |
| **(c)** | $[P(Y < \mu \mid Y < 17) = ]$ | |
| | $\frac{P(Y < \mu)}{P(Y < 17)}$ or $\frac{0.5}{0.6}$ | M1 |
| | $= \frac{5}{6}$ awrt $\mathbf{0.833}$ | A1 (2) |
| | | **[5]** |

| | Notes |
|---|---|
| **(a)** | B1 for 0.4 Note: do **not** isw if 0.6554 is given as answer after 0.4 has been seen. |
| **(b)** | M1 for indicating $P(Y < \mu) = 0.5$ (may be seen on a diagram) |
| **(c)** | M1 for a correct statement $\frac{P(Y < \mu)}{P(Y < 17)}$ or a correct ratio of probabilities<br>May be implied by $\frac{P(Y < \mu)}{0.6}$ or $\frac{0.5}{P(Y < 17)}$ |

| Question | Scheme | Marks |
|---|---|---|
| **5. (a)** | $-2a+(0)+2a+4c=0.8$ or $4c=0.8$ | M1 |
| | **$\underline{c = 0.2}$** | A1 |
| | | (2) |
| **(b)** | $4a+(0)+4a+16c=5$ or $8a+16c=5$ | M1 |
| | $8a + 3.2 = 5$ so **$\underline{a = 0.225}$ or $\underline{\frac{9}{40}}$** | A1 |
| | $2a+b+c=1$ so $b=1-"0.2"-2\times"0.225"$ | M1 |
| | **$\underline{b = 0.35}$ or $\underline{\frac{7}{20}}$** | A1ft |
| | | (4) |
| **(c)** | $\text{Var}(X) = 5-0.8^2$, $= \underline{\mathbf{4.36}}$ | M1A1 |
| | | (2) |
| **(d)** | $[5 - 3\text{E}(X) = 5 - 3\times0.8\ ]$ $= \underline{\mathbf{2.6}}$ | B1 |
| | | (1) |
| **(e)** | $3^2\text{Var}(X) = 9\times4.36$, or $[\text{E}(Y^2) - (\text{E}(Y))^2] = 46 - 2.6^2$ $= \underline{\mathbf{39.24}}$ awrt $\underline{\mathbf{39.2}}$ | M1, A1 |
| | | (2) |
| **(f)** | $Y \geq 0 \Rightarrow 5-3X \geq 0 \Rightarrow 5 \geq 3X$ | M1 |
| | $X \leq 1\frac{2}{3}$ | A1 |
| | $[\text{P}(Y \geq 0) = \text{P}(X \leq 0) =]$ $\text{P}(X = -2) + \text{P}(X = 0)$ <u>or</u> $a + b$ | M1 |
| | **$\underline{= 0.575}$ or $\underline{\frac{23}{40}}$** | A1ft |
| | | (4) |
| | | **[15]** |

| | Notes |
|---|---|
| **(a)** | M1 for forming an equation using E($X$) = 0.8 with at least 2 non-zero products correct |
| **(b)** | 1st M1 for forming an equation using E($X^2$) = 5 with at least 2 non-zero terms correct, ft their $c$<br>1st A1 for 0.225 or any equivalent fraction<br>2nd M1 for forming an equation for $b$ using the sum of their prob'=1, (award M1 if their($2a+b+c$)=1)<br>2nd A1ft for 0.35 or a value of $b$ such that their $2a+b+c = 1$ (where $a$, $b$ and $c$ are all probabilities) |
| **(c)** | M1 for a correct expression $5-0.8^2$ (Division by 4 at any stage is M0) |
| **(e)** | M1 for $9\times\text{Var}(X)$ ft their Var($X$). Condone $-3^2$ if +9 is used later |
| | **Correct answer with no incorrect working seen in (f) scores 4/4** |
| **(f)** | 1st M1 for attempting to solve the inequality in $X$ as far as $p \geq qX$ with one of $p$ or $q$ correct<br>1st A1 for $X \leq 1\frac{2}{3}$ or $X \leq 0$ or $X \leq$ awrt 1.7<br>2nd M1 for P($X = 0$) + P($X = -2$) Allow letters "$a + b$" here or ft their values.<br>2nd A1ft for their ($a + b$) or 0.575 (where $a$, $b$ and $a+b$ are all probabilities) |
| **Alt-Method** | 1st M1 for attempting to convert $X$ into $Y$ (at least 1 y-value correct) (maybe seen earlier)<br>1st A1 for 11, 5, –1 and –7 all correct<br>2nd M1 for P($Y$=11) + P ($Y$=5)<br>2nd A1ft for their ($a + b$) or 0.575 (where $a$, $b$ and $a+b$ are all probabilities) |

| Question | Scheme | Marks |
|---|---|---|
| **6. (a)** | $P(S) = 0.31 + p$ , $P(D) = 0.35$ , $P(S \cap D) = 0.14$ | M1 |
| | $(0.31 + p)(0.35) = 0.14$ oe | M1 |
| | $P(S) = 0.4$ <u>or</u> $0.31 + p = 0.4$ <u>or</u> $0.35p = 0.0315$ | A1 |
| | $p =$ **<u>0.09</u>** | A1 |
| | | (4) |
| **(b)** | $P(S \cup M \cup D) = 1$ so $q = 1 - (0.17+0.10+0.15+0.06+0.04) - p$ <u>or</u> $0.48 - p$ | M1 |
| | $q =$ **<u>0.39</u>** | A1ft |
| | | (2) |
| **(c)(i)** | $[P(D \mid S \cap M =] \frac{P(D \cap S \cap M)}{P(S \cap M)} = \frac{0.10}{0.27}$ | M1 |
| | $= \underline{\frac{10}{27}}$ or awrt **<u>0.370</u>** | A1 |
| **(ii)** | $[P(D \mid S' \cap M =] \frac{P(D \cap S' \cap M)}{P(S' \cap M)} = \frac{0.15}{0.54}$ | M1 |
| | $= \underline{\frac{5}{18}}$ or awrt **<u>0.278</u>** | A1 |
| | | (4) |
| **(d)** | 27 order $S \cap M$ so expect $27 \times \frac{10}{27} D$ <u>or</u> 36 order $S' \cap M$ so expect $36 \times \frac{5}{18} D$ | M1 |
| | So expect **<u>20 (desserts)</u>** | A1cao |
| | | (2) |
| | | **[12]** |

| | Notes |
|---|---|
| **(a)** | 1st M1 for attempting P($S$), P($D$) and $P(S \cap D)$ with at least 2 correct.<br>These may be seen in a conditional probability.<br>NB $P(S \mid D) = \frac{0.14}{0.35}$ and $P(D \mid S) = \frac{0.14}{0.31 + p}$ |
| | 2nd M1 using the independence condit' and their values to form a suitable equation for $p$ or P($S$) |
| | 1st A1 for $P(S) = 0.4$ <u>or</u> $0.31 + p = 0.4$ <u>or</u> $0.35p = 0.0315$ (i.e. one move from $p = \ldots$) |
| **(b)** | M1 for using sum of probabilities = 1 and ft their $p$ |
| | A1ft for 0.48 – "their $p$" (provided 0 < their $p$ < 0.48 ) |
| **(c)** | 1st M1 for a correct ratio of probabilities <u>or</u> a correct ratio expression with at least one correct probability substituted. (M0 if numerator is P($D$)×P( $S \cap M$ ) or numerator>denominator) |
| | 1st A1 for $\frac{10}{27}$ or awrt 0.370 |
| | 2nd M1 for a correct ratio of probabilities <u>or</u> a correct ratio expression with at least one correct probability substituted. (M0 if numerator is P($D$)×P( $S' \cap M$ ) or numerator>denominator) |
| | 2nd A1 for $\frac{5}{18}$ or awrt 0.278 |
| **(d)** | M1 for at least one correct calculation ft their probabilities from (c).<br>i.e. either 27×their (c)(i) or 36×their (c)(ii) |

| Question | Scheme | Marks |
|---|---|---|
| **7. (a)** | $[\mathrm{P}(D > 50) =] \mathrm{P}\left(Z > \frac{50-32}{12}\right)$ | M1 |
| | $= 1 - \mathrm{P}(Z < 1.5)$ or $1 - 0.9332$ | M1 |
| | = **awrt <u>0.0668</u>** or 6.68% | A1cso |
| | | (3) |
| **(b)** | $\mathrm{P}(D > d) = 0.191 + 0.0668 = 0.2578$ <u>or</u> $\mathrm{P}(D < d) = 0.7422$ | B1 |
| | $\frac{d-32}{12} = 0.65$ (calc gives 0.65014… or 0.65012…) | M1A1 |
| | $d =$ **<u>39.8</u>** | A1 |
| | | (4) |
| **(c)** | $0.0668 \times 0.191^2 [= 0.0024369...]$ | M1 |
| | $[...] \times 3$ | M1 |
| | = 0.00731079… = **awrt <u>0.0073</u>** | A1 |
| | | (3) |
| | | **[10]** |

| | Notes |
|---|---|
| **(a)** | 1st M1 for standardising with 50, 32 and 12. Allow $\pm$<br>2nd M1 for $1 - \mathrm{P}(Z < 1.5)$ seen i.e. a correct method for finding $\mathrm{P}(Z > 1.5)$ e.g. 1 – tables value<br>A1cso for awrt 0.0668 with both Ms scored and no incorrect working seen.<br>Condone incomplete notation and condone use of different letters for $Z$. |
| **(b)** | B1 for awrt 0.2578 (calc = 0.257807..) or awrt 0.7422 (calc = 0.742192..)<br>may be implied by $z$ = awrt 0.65<br>M1 for standardising with 32 and 12, i.e. $\pm\frac{d-32}{12}$ (equating to a probability is M0)<br>1st A1 for $z$ = awrt 0.65 **and** a correct equation in $d$ (with compatible signs)<br>2nd A1 for awrt 39.8 |
| **(c)** | 1st M1 for $0.0668 \times 0.191^2$ or sight of awrt 0.0024 (may be seen embedded in part of an expression, e.g. '$n \times 0.0668 \times 0.191^2$')<br>(condone 6.68% × 19.1% ×19.1% if the final answer given is < 1)<br>2nd M1 for any expression of the form $3pq^2$ where $p$ and $q$ are both probabilities<br>A1 for awrt 0.0073 allow awrt 0.73% but 0.73 is A0 |

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