Mark Scheme (Results)

January 2014

Pearson Edexcel International Advanced Level

Statistics 1 (WST01/01)
**Edexcel and BTEC Qualifications**

Edexcel and BTEC qualifications are awarded by Pearson, the UK’s largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at [www.edexcel.com](http://www.edexcel.com) or [www.btec.co.uk](http://www.btec.co.uk). Alternatively, you can get in touch with us using the details on our contact us page at [www.edexcel.com/contactus](http://www.edexcel.com/contactus).

---

**Pearson: helping people progress, everywhere**

Pearson aspires to be the world’s leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We’ve been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: [www.pearson.com/uk](http://www.pearson.com/uk)

---

January 2014

Publications Code IA037873

All the material in this publication is copyright

© Pearson Education Ltd 2014
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.
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 $\checkmark$ 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
   - $\ast$ The answer is printed on the paper
   - $\square$ 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.
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Scheme</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.(a)</td>
<td>$S_{cs} = 380 - \frac{111 \times 21}{6} = -8.5$ o.e.</td>
<td>M1A1</td>
</tr>
<tr>
<td></td>
<td>$S_{ss} = 79 - \frac{21^2}{6} = 5.5$ o.e.</td>
<td>A1</td>
</tr>
<tr>
<td>(b)</td>
<td>$r = \frac{S_{cs}}{\sqrt{S_{cs}S_{ss}}} = \frac{-8.5}{\sqrt{321.5 \times 5.5}} = -0.20214...$ awrt $-0.202$</td>
<td>M1A1</td>
</tr>
<tr>
<td>(c)</td>
<td>No evidence of, or weak, correlation (between cost and satisfaction) from data or evidence of negative correlation. [Allow $r$ close to zero or $r &lt; 0$]</td>
<td>B1ft,</td>
</tr>
<tr>
<td></td>
<td>Poor basis for a decision, Brad is wrong or equivalent, e.g. “paying more doesn’t give a better service”</td>
<td>dB1ft</td>
</tr>
<tr>
<td></td>
<td>Total 7</td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

(a) M1 for a correct expression for $S_{cs}$ or $S_{ss}$

1st A1 for $S_{cs} = -8.5$ (Condone $S_{sy} = \ldots$) accept $-\frac{17}{2}$

2nd A1 for $S_{ss} = 5.5$ (Condone $S_{xy}$ or even $S_{xx} = \ldots$) accept $\frac{11}{2}$

(b) M1 for attempt at correct formula, values must be substituted.

Must have their $S_{cs}, S_{ss}$ and given $S_{xx}$ in the correct places. Condone missing “−”

Award M1A0 for awrt $-0.20$ or even $-0.2$ with no expression seen

M0 for $\frac{380}{\sqrt{79 \times 2375}}$ or $\frac{380}{\sqrt{79 \times 321.5}}$

If $|r| > 1$ score B0B0 in (c)

(c) 1st B1 for a reason: no or weak (or negative) correlation (between cost and satisfaction )

This may be implied by a contextual statement e.g. “as he pays more satisfaction decreases”

2nd d B1 dependent on suitable reason for saying that Brad’s decision is wrong/bad/poor etc ft

If $0.5 < r \leq 1$ allow the following ft

1st B1 for positive correlation

2nd dB1 for Brad’s decision is a good one
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Scheme</th>
<th>Marks</th>
</tr>
</thead>
</table>
| 2. (a)          | \[
a = \frac{77 \times 1 + 82 \times 2 + \ldots + 1385 \times 277}{15} = \frac{1385}{15} = \frac{277}{3} = 92.\overline{3}
\]
|                 | awrt 92.3                                                             | M1 A1  |
|                 | \[
b = [\frac{89.5 + 7.5 - 5}{9 - 5}] \cdot (94.5 - 89.5) = 92.625
\]
|                 | awrt 92.6                                                             | M1 A1  |
|                 | \[
c = \frac{1 \times 77^2 + 2 \times 82^2 + \ldots - 92.\overline{3}^2}{15} = 64.88\ldots
\]
|                 | awrt 64.9                                                             | M1 A1  |
|                 | (b) Median in 2010 (92.6 kg) > Median in 1990 (82.0 kg)                |        |
|                 | Mean in 2010 (92.3 kg) > Mean in 1990 (83.0 kg)                        | either B1 |
|                 | Rugby coach’s claim supported.                                        | dep dB1|
|                 | (6)                                                                   |        |

**Notes**

(a) Correct answer only in part (a) scores full marks and answers must be decimals not fractions.

**NB mid points are:** 77, 82, 87, 92, 97, 102, 107

1. **M1** for attempt to use correct midpoints in an expression for mean.
   
   Accept \[ \sum \frac{fx}{15} \]
   
   with at least 3 correct \textit{fx} products seen and intention to add

   or 1300 < \[ \sum \frac{fx}{15} < 1400 \]

2. **A1** for awrt 92.3 (don’t insist on 3 sf)

(b) 1. **B1** for a suitable reason i.e. identifying an increase in mean or median.

   Ignore any comment about variance.

2. **dB1** dependent on a suitable reason for stating that the coach’s claim is supported.

   Allow these marks provided both their \[ a > 83.0 \] and \[ b > 82.0 \]

   If it is \textbf{NOT} the case that both \[ a > 83.0 \] and \[ b > 82.0 \] then allow a ft \textbf{provided M1 scored for both} \[ a \] and \[ b \] in part (a)
### Question 3

#### (a)

- **Scheme**
  - `B2/1/0`
  - `-1eeoo`

#### (b)

- ‘Negative correlation’ or ‘as $t$ increases, $p$ decreases’ or
- ‘Points close to a straight line’ or ‘linear correlation’

- **Marks**
  - B1

#### (c)

- $b = \frac{S_y}{S_x} = \frac{-6080}{254} = -23.937$
- $a = \bar{p} - bt = 470 + 23.937 \times 19.5 = 936.7717$
- $p = 936.7717 - 23.937t$ \hspace{1cm} `awrt \ p = 937 - 23.9t`

- **Marks**
  - M1
  - A1

#### (d)

- $p = 937.7717 - 23.937 \times 20, = 458.0315$ \hspace{1cm} `awrt (\£) 458`

- **Marks**
  - M1, A1

#### (e)

- Extrapolation or 39 (or it’s) outside the range of data (or table)
- BUT B0 if they calculate $p$ and say this is outside the range of the data
- Not a good decision or the prediction would be unreliable

- **Marks**
  - dB1

**Total 11**

### Notes

#### (a)

- 1st B1 for at least 7 points plotted correctly (i.e. within (not on) the circles on the overlay)
- 2nd B1 for all 8 points plotted correctly (i.e. within (not on) the circles on the overlay)

#### (b)

- B1 for a suitable comment conveying the idea of linear correlation
- NB “negative relationship” or “skew” scores B0 but apply ISW if a correct ans. is seen

#### (c)

- 1st M1 for a correct expression for gradient $b$ or awrt $-24$ Allow fractions e.g. $-\frac{3040}{127}$
- 2nd M1 for a correct method for $a$. Follow through their value for $b$
  - Allow sign slip on $b$ only if a correct formula for $a$ is seen
- 1st A1 for $a = awrt 937$
- 2nd A1 for a correct equation in $p$ and $t$ (not $x, y$) with $a = awrt 937$ and $b = awrt -23.9$ No fractions

#### (d)

- M1 for substituting $t = 20$ in their equation
- A1 for awrt 458 [ NB use of 3sf for $a$ and $b$ will give awrt £459 but scores A0 here]

#### (e)

- 1st B1 for a suitable reason that would lead to stating that the decision was poor/bad/wrong
  - Stating that 39 is an “outlier” is B0
- 2nd dB1 dependent on a suitable reason and stating, or implying, it is not a sensible decision
4. (a) \[ a + \frac{1}{10} + \frac{1}{5} + \frac{3}{10} + b = 1 \quad \text{or} \quad a + b = \frac{2}{5} \]
\[ -a + 0 + \frac{1}{5} + \frac{6}{10} + 3b = \frac{9}{5} \quad \text{or} \quad 3b - a = 1 \]
Solving gives \[ a = \frac{1}{20}, b = \frac{7}{20} \]

\[ \begin{array}{|c|c|c|c|c|}
\hline
x & -1 & 0 & 1 & 2 \\
\hline
[F(x)] & \frac{1}{20} & \frac{3}{20} & \frac{7}{20} & \frac{13}{20} \\
\hline
0.05 & 0.15 & 0.35 & 0.65 & 1 \\
\hline
\end{array} \]

(b) \[ P(X < 2.5) = F(2) = \frac{13}{20} \quad \text{or} \quad 0.65 \]

(c) \[ E(X^2) = 1 \times 0.05 + 0 \times 1 + 0.2 \times 0.2 + 4 \times 0 \times 0.3 + 9 \times 0.35 = 4.6 \quad \text{or} \quad \frac{23}{5} \]
\[ \text{Var}(X) = E(X^2) - 1.8^2 \quad [ = 1.36 \quad \text{or} \quad \frac{34}{25} ] \]
\[ \text{Var}(3 - 2X) = (-2)^2 \text{Var}(X) \\
= 4 \times 1.36 = 5.44 \]

Alt: 
State \( a \) and \( b \) correctly

(a) 1st M1 for a correct linear equation in \( a \) and \( b \) based on sum of probs. = 1
2nd M1 for an attempt at a second linear equation in \( a \) and \( b \) based on \( E(X) = 1.8 \) Allow one slip.
3rd M1 for an attempt to solve their 2 linear equations. Must reduce to a linear equation in one variable. May be implied by 1st M1 and 2nd M1 followed by correct answers.
A1 dependent on all 3 Ms scored for \( a = 0.05 \) and \( b = 0.35 \) or exact fraction equivalents

(b) 1st B1 for at least 4 correct values for \( F(x) \)
2nd B1 for all values of \( F(x) \) correct
Condone no \( F(x) \) or even \( P(x) \) if in a correct table. If not in a table they must state \( F(-1) = 0.05 \) etc

(d) 1st M1 for an attempt to find \( E(X^2) \). At least 3 correct terms or sight of 4.6 or correct \( \text{Var}(X) \)
NB \[ \frac{4.6}{5} \] loses the M1 for \( E(X^2) \) and the next M1 for \( \text{Var}(X) \) too
2nd M1 for an attempt to find \( \text{Var}(X) \). Follow through their “4.6” but must see \(-1.8^2 \) or 1.36
3rd M1 for correct use of \( \text{Var}(aX + b) \) formula. Condone \(-2^2 \) if this later becomes +4
A1 for 5.44 Accept \[ \frac{136}{25} \] or exact equivalent
5. (a) [Image of a diagram showing loops labeled F, R, and S with numbers 30, 25, 12, and 11.]

(b) \(F\) and \(S\) or \(R\) and \(S\)

(c) \(P\left(\left[F \cup R \cup S\right]'\right) = \frac{33}{100}\) or 0.33

(d) \(P(R) = \frac{30 + 12}{100} = \frac{21}{50}\) or 0.42

(e) \(P\left(F \cup S\right) = \frac{30 + 25}{100} = \frac{11}{20}\) or 0.55

(f) \(\left[P\left(F \mid R\right)\right] = \frac{P\left(F \cap R\right)}{P(R)} = \frac{\text{"0.30"}}{\text{"0.42"}} = \frac{30}{42}\) or \(\frac{5}{7}\) (o.e.)

Notes

(a) **In the diagram do not treat a blank space as zero. Allow probabilities or integers**

1st B1 for 3 labelled loops and a box. The 33 is not required for any marks in (a)

2nd B1 for \(F \subseteq R\) or indicated by zeros

3rd B1 for 30 and 12 correctly placed and \(n(F) = 30\) and \(n\left(F' \cap R\right) = 12\)

4th B1 for \(S\) a separate loop, or indicated by zeros, and the 25

(b) B1 for a correct pair. If there is more than one pair then each pair must be correct.

Do not allow \(P(F)\) etc or e.g. \(P\left(R \cap S\right) = 0\)

(c),(d),(e) B1 cao for each answer. Accept any exact equivalent (fractions or decimals) for the probabilities

(f) M1 ft their “30” and their answer to (d). For a correct ratio of their probabilities or a correct ratio expression and at least one correct probability. If num > den score M0

A1 for \(\frac{5}{7}\) or any exact equivalent. Must be proper fraction not \(\frac{0.3}{0.42}\)

NB \(\frac{0.3}{0.42} = 0.714\) is A0 since it is not a proper fraction and the answer is not exact

Condone \(P(R \mid F) = \frac{30}{42}\) and allow M1A1 for the correct answer

but \(P(R \mid F) = \frac{P(R \cap F)}{P(F)} = \frac{0.30}{0.42} = \frac{30}{42}\) is M0A0
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Scheme</th>
</tr>
</thead>
</table>
| 6. (a) | \[
X \sim N(1.04, \ 0.17^2)
\]
\[
P(X < 1) = P\left(Z < \frac{1-1.04}{0.17}\right)
= P(Z < -0.23529...)
= 1 - 0.5948 = 0.4052
\]
(Accept 0.405-0.407) M1A1

(b) \[
P(Y < 1) = 0.05
\]
\[
\frac{1-\mu}{0.17} = -1.6449
\]
\[
\mu = 1 + 1.6449 \times 0.17 = 1.2796 ...
\]
awrt 1.28 A1

(c) \[
P(S < 1) = 0.01
\]
\[
\frac{1-1.04}{\sigma} = -2.3263
\]
\[
\sigma = \frac{0.04}{2.3263} = 0.0171946...
\]
awrt 0.0172 A1

<table>
<thead>
<tr>
<th>Notes</th>
</tr>
</thead>
</table>
| (a) 1st M1 for attempting to standardise with 1, 1.04 and 0.17 Allow ±
2nd M1 for attempting 1 − p where (0.5 < p < 0.6)
A1 for answers in the range 0.405 ~ 0.407 (Calc gives 0.4069902…)
Allow any alternative letters to \( \mu \) and \( \sigma \) in parts (b) and (c)

(b) M1 for an attempt to standardise (allow ±) with 1, 0.17 and \( \mu \) and set = ± any \( z \) value (|\( z \)| > 1)
B1 for \( z = \pm 1.6449 \) (or better. Calc gives 1.6448536..) used as a \( z \) value. Do not allow 1 − 1.6449
[May be implied by answer that rounds to 1.2796]
A1 for awrt 1.28 (can be scored for using a \( z \) value of 1.64 or 1.65)
Must follow from correct working but a range of possible \( z \) values are OK
Ans only If answer is awrt 1.28 score M1B0A1 (unless of course \( z = 1.6449 \) seen) but awrt 1.2796 scores 3/3

(c) M1 for an attempt to standardise with 1, 1.04 and \( \sigma \) and set = ± any \( z \) value (|\( z \)| > 2)
B1 for \( z = \pm 2.3263 \) (or better) (Calc gives 2.3263478…) used as a \( z \) value
If B0 scored in (b) for using a value in [1.64, 1.65] but not 1.6449 or better, allow awrt 2.32 or 2.33 here
A1 for awrt 0.0172 Must follow from correct working but a range of possible \( z \) values are OK
Ans only If answer is awrt 0.0172 score M1B0A1 (unless of course \( z = 2.3263 \) or better is seen)
If B1 scored in (b) and \( z = 2.3263 \) or better is not seen here then require an answer in the range 0.17194 < \( \sigma \) < 0.17195 to award 3/3
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Scheme</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. (a)</td>
<td>[ P(M \mid L) = \frac{P(M \cap L)}{P(L)} = \frac{\frac{3}{5} \times \frac{1}{2}}{\frac{3}{10}} = 0.40 \quad \text{(o.e.)} ]</td>
<td>M1 A1</td>
</tr>
<tr>
<td></td>
<td>[ x = [P(L \mid F)] = \frac{P(L \cap F)}{P(F)} = \frac{\frac{3}{10} - \frac{3}{5} \times \frac{1}{2}}{1 - \frac{3}{5}} \quad \text{or} \quad \frac{3}{5} \times \frac{1}{5} + \left(1 - \frac{3}{5}\right)x = \frac{3}{10} ]</td>
<td>M1 A1</td>
</tr>
<tr>
<td></td>
<td>[ x = \frac{0.3 - 0.12}{0.40} \quad \text{or} \quad 0.4x = 0.3 - 0.12 ]</td>
<td>M1 A1</td>
</tr>
<tr>
<td></td>
<td>[ x = 0.45 \quad \text{(o.e.)} ]</td>
<td></td>
</tr>
<tr>
<td>7. (b)</td>
<td>[ P(M \cap R) = 0.6 - P(M \cap L) \quad \text{or} \quad 0.6 \times (1 - 0.2) ]</td>
<td>M1 A1</td>
</tr>
<tr>
<td></td>
<td>[ = 0.48 \quad \text{(o.e.)} ]</td>
<td></td>
</tr>
<tr>
<td>7. (c)</td>
<td>P(one is left handed and the other right handed) = [ 2 \times \frac{3}{10} \times \frac{7}{10} = \frac{21}{50} \quad \text{or} \quad 0.42 ]</td>
<td>M1, A1</td>
</tr>
</tbody>
</table>

**Notes**

- **(a)** M1 for a fully correct ratio e.g. \( \frac{0.12}{0.30} \) or a correct ratio expression and one correct prob.
  - If numerator > denominator then M0
  - A1 for 0.40 or any exact equivalent

- **(b)** 1st M1 for an equation for \( x \) with at least 2 of: \( \frac{3}{5} \times \frac{1}{2} \) or \( \frac{3}{10} \) or \( (1 - \frac{3}{5}) \) correct
  - BUT \( \frac{3}{5} \times \frac{1}{2} \) is M0
  - or allow M1 for \( P(L \cap F) = 0.18 \)
  - 2nd M1 for a fully correct expression for \( x = \ldots \) or \( 0.4x = \ldots \)
  - A1 for 0.45 or any exact equivalent

- **(c)** M1 for a correct expression with 0.6 follow through their \( P(M \cap L) = 0.12 \)
  - A1 for 0.48 or any exact equivalent

- **(d)** M1 for a fully correct expression including the 2. Allow \( 1 - 0.3 \) instead of 0.7
  - A1 for 0.42 or any exact equivalent

**NB** You may see Venn or tree diagram drawn but marks are given when values are used in correct expressions as above
8. (a) Total area of bars = 400 small squares
Area required = \(40 \times 4 + 20 \times 6 + 6 \times 10 = 340\) small squares
No of staff = \(\frac{340}{400} \times 40 = 34\)

(b) Median is \((2+) \times 4 \times 3 = 3\) or \((5-) \times \frac{8}{12} \times 3 = 3\)

(c) Mean is \(\frac{\sum fx}{40} = \frac{1 \times 16 + 3.5 \times 12 + 7.5 \times 6 + 15 \times 4 + 25 \times 2}{40} = \frac{213}{40} = 5.325\)

(d) (Positive) skew but not negative or there are outliers (which affect mean)
Median

Notes

1st B1 for a correct attempt to calculate the whole area (400 small squares o.e.)
Accept 160 + 120 + 60 + 40 + 20 or 80 + 60 + 30 + 20 + 10 = 200 or frequencies: 16 + 12 + 6 + 4 + 2
or cm\(^2\) 6.4 + 4.8 + 2.4 + 1.6 + 0.8 = 16 or key: 10 small squares = 1 person (o.e.)
2nd B1 for a correct attempt to calculate required area (Accept 160 + 120 + 60)
or frequencies: 16 + 12 + 6 or cm\(^2\) 6.4 + 4.8 + 2.4 = 13.6
M1 for a correct expression using their 400 and their 340
A1 for 34
If using frequencies they get M1A1 together when 34 is seen.
An answer of 34 will usually score 4/4 unless there is incorrect working seen

NB frequencies are: 16, 12, 6, 4, 2 and mid-points are: 1, 3.5, 7.5, 15, 25

(b) M1 for \(\frac{20 - 16}{12} \times (5 - 2)\) or \(\frac{20.5 - 16}{12} \times (5 - 2)\) or similar expressions working down
Look out for methods based on areas should have 1st bar + \(\frac{1}{3}\) (2nd bar) if working up or
(5th + 4th + 3rd bars) + \(\frac{1}{3}\) (2nd bar) if working down. E.g. 16 + 4(\(x - 2\)) = 20
A1 for 3 or (if using \(n + 1\) accept 3.125 or awrt 3.13)

(c) M1 for an attempt at \(\frac{\sum fx}{40}\) where at least 3 correct products of \(\sum fx\) are seen
or \(\sum fx = \text{awrt} 200\) (1 sf)
A1 for 5.325 or any exact equivalent e.g. \(\frac{213}{40}\) and accept 5.33
Accept 5 h 19 mins or 5h 20 mins

(d) 1st B1 for a reason e.g. that the data is skewed
Allow mention of “extreme values” or “outliers”
Do not allow for negative skew or “anomalies”
2nd dB1 dependent on mentioning skew for choosing median
SC Allow B0B1 for “Choose median since the data has negative skew” o.e.