



# Mark Scheme (Results)

Summer 2019

Pearson Edexcel International Advanced Level  
In Statistics S1 (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.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

## PEARSON 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.

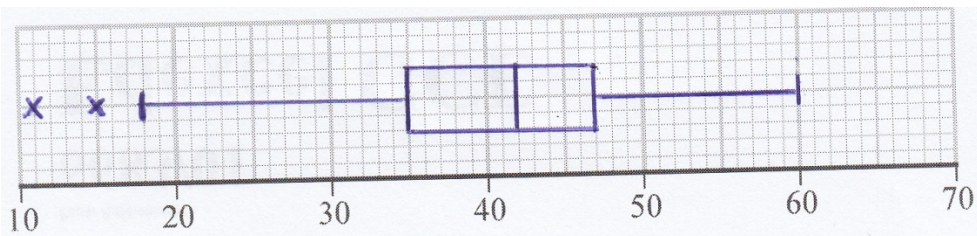
- bod – benefit of doubt
- ft – follow through
- the symbol  $\surd$  will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: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

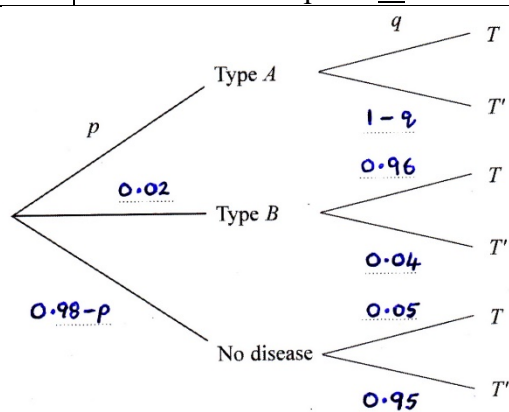
**Special notes for marking Statistics exams (for AAs only)**

- If a method leads to "probabilities" which are greater than 1 or less than 0 then M0 should be awarded unless the mark scheme specifies otherwise.
- Any correct method should gain credit. If you cannot see how to apply the mark scheme but believe the method to be correct then please send to review.
- For method marks, we generally allow or condone a slip or transcription error if these are seen in an expression. We do not, however, condone or allow these errors in accuracy marks.
- If a candidate is "hedging their bets" e.g. give Attempt 1...Attempt 2...etc then please send to review.

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Marks                 |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 1 (a)           | $\bar{x} = \frac{58}{40} = \underline{1.45}$ $\sigma^2 = \frac{84.829}{40} - 1.45^2$ $= 0.018225 \quad = \text{awrt } \underline{0.0182}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | B1<br>M1<br>A1<br>(3) |
| (b)             | New mean = <u>145</u><br>New $\sigma$ = <u>13.5</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | B1ft<br>B1<br>(2)     |
| (c)(i)          | <b>Reason</b> e.g. mean of two extra children is the same as the original mean<br><b>Conclusion</b> the mean is therefore unchanged or = <u>145</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | M1<br>A1              |
| (ii)            | <b>Reason</b> e.g. extra children <u>more than 1 sd</u> from mean so increased spread<br><b>Conclusion</b> therefore standard deviation will increase                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | M1<br>A1<br>(4)       |
| <b>[9]</b>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| <b>Notes</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| (a)             | B1 for a correct mean (accept an exact fraction)<br>M1 for a correct expression for $\sigma^2$ (or $s^2$ ) (ft their mean and condone inside square root)<br>A1 for awrt 0.0182 (NB $s^2 = 0.0186923...$ awrt 0.0187) <b>Correct ans only 2/2</b> [No fraction]                                                                                                                                                                                                                                                                                                                                                                          |                       |
| (b)             | 1 <sup>st</sup> B1ft for new mean = 145 <u>or</u> $100 \times \text{their } \bar{x}$<br>2 <sup>nd</sup> B1 for new s.d. = awrt 13.5 (accept $s = 13.6719...$ or awrt 13.7)                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                       |
| (c)(i)          | 1 <sup>st</sup> M1 for a suitable reason. May see recalculation e.g. $\frac{"145" \times 40 + 130 + 160}{42}$ (o.e.)<br>e.g. "both 15 away from the mean" <u>or</u> "both same distance from the mean" <u>or</u> "mean of new values is 145 <u>or</u> the same"<br>1 <sup>st</sup> A1 for 145 or 1.45 or "no change" but M1 must be seen<br>[no further comment needed if answer matches their (b) or (a)]                                                                                                                                                                                                                               |                       |
| (ii)            | 2 <sup>nd</sup> M1 for a suitable reason but must have idea that the "gap" (= 15) > 1 st. dev. [ft $\sigma < 15$ ]<br>2 <sup>nd</sup> A1 for stating standard deviation will be <u>greater</u> (o.e.) [M1 must be seen]<br><b>Calculations</b> (You may see)<br>e.g. $\Sigma y^2 = 84.829 + 1.3^2 + 1.6^2 = 89.079$ leading to $\sigma = \sqrt{0.01842...} = 0.13575... \text{ or } \underline{13.6} \text{ (cm)}$<br><u>or</u> $\frac{89.079}{42} = 2.1209... > \frac{84.829}{40} = 2.1207...$ but $\frac{\Sigma x}{n}$ stays the same so $\sigma$ greater<br>BUT M0A0 unless we see mention of 15 (cm) or 1.5 (m) being more than 1 sd |                       |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Marks                  |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| 2. (a)(i)       | [IQR = 47 – 33 =] <b>14</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | B1                     |
| (ii)            | [Range = 54 – 11 =] <b>43</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | B1                     |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | (2)                    |
| (b)             | e.g. $Q_2 - Q_1 (=9) > (5=) Q_3 - Q_2$<br>Therefore <u>negative</u> (skew)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | M1<br>A1               |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | (2)                    |
| (c)             | 25 → 37 ⇒ new $Q_1 = 35$ (may be on box plot)<br>[54 → 60 (implies upper whisker now at 60) but no change to $Q_3$ ]<br>New IQR = 12 so need to re-calculate for outliers<br>Outliers now [ $> 47 + 18 = 65$ or] $< 35 - 18 = 17$<br><b>Box Plot</b><br>                                                                                                                                                                                                                                                                                                                                                                                                           | B1<br>M1<br>A1         |
|                 | Box and two whiskers with median still at 42<br>Lower quartile at their 35 ( $\neq 33$ ) and upper quartile unchanged at 47<br>Two outliers at 11 and 15<br>Lower whisker at 18 (or 17) <u>and</u> upper whisker at 60                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | M1<br>A1ft<br>A1<br>A1 |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | (7)                    |
| (d)             | The value of pmcc is small <u>or</u> weak correlation (o.e.)<br>Therefore the complaint is <u>not</u> supported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | M1<br>A1               |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | (2)                    |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>[13]</b>            |
| <b>Notes</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |
| (a)(i)          | 1 <sup>st</sup> B1 for 14<br>2 <sup>nd</sup> B1 for 43                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |
| (b)             | M1 for a suitable reason or calculation (allow longer whisker on left etc)<br>A1 for negative skew (dep on M1 seen) “left skew” etc is A0 [Condone incorrect “9” or “5”]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                        |
| (c)             | B1 for new lower quartile at 35 (stated or on box plot)<br>1 <sup>st</sup> M1 for finding the new IQR ( $< 14$ ) and attempting to re-calculate for outliers<br>1 <sup>st</sup> A1 for at least the correct lower limit of 17 seen<br>2 <sup>nd</sup> M1 for drawing a box with only two whiskers and median at 42 (all points $\pm 0.5$ square)<br>2 <sup>nd</sup> A1ft for lower quartile of “35” (changed from 33) and upper quartile unchanged at 47<br>3 <sup>rd</sup> A1 for only two outliers at 11 and 15 (no overlap with whisker)<br>4 <sup>th</sup> A1 for lower whisker ending at 18 (or 17) <u>and</u> upper whisker ending at 60<br>Correct box plot scores all except 1 <sup>st</sup> M1A1 (i.e. 5/7) this M1A1 requires some working |                        |
| (d)             | M1 for comment that pmcc is “small” so little correlation (just saying $< 0$ is not enough)<br>Allow e.g. “not significant” <u>or</u> “not relevant” <u>or</u> $-0.5 < r < 0.5$ <u>or</u> “not close to $-1$ ”<br>but “no correlation” is M0<br>A1 for suggesting the complaint is <u>not</u> supported e.g. “little evidence to support claim”<br>Dep on M1 seen NB M1A0 is possible                                                                                                                                                                                                                                                                                                                                                                |                        |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Marks                                      |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| 3. (a)          | 0.02 and $0.98 - p$ correctly placed [no mixing of % and probability]<br>0.96 and 0.05 plus $1 - q$ , 0.04, 0.95 correctly placed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | B1<br>B1<br>(2)                            |
| (b)             | $P(T) = pq + 0.02 \times 0.96 + (0.98 - p) \times 0.05 = 0.169$<br>$\{pq - 0.05p = 0.1008\}$<br>$P(\text{do not have disease}   T) = \frac{(0.98 - p) \times 0.05}{0.169} = \frac{41}{169}$<br>So $p = \underline{0.16}$<br>e.g. $0.16q - 0.16 \times 0.05 = 0.1008$<br>$q = \underline{0.68}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | M1; A1<br>M1A1ft<br>A1<br>dM1<br>A1<br>(7) |
| (c)(i)          | $P(\text{type } A   T \text{ and not type } B) = \frac{pq}{pq + (0.98 - p) \times 0.05} = \frac{0.1088}{0.1088 + 0.041}$<br>$= 0.7263... \quad \text{awrt } \underline{0.726}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | M1A1ft<br>A1<br>(3)                        |
| (ii)            | Should find test useful, doctor knows there is a much greater chance that the person has type $A$ (0.73 compared to 0.16 or 0.163... [from $\frac{0.16}{0.98}$ ])                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | B1<br>(1)                                  |
| <b>[13]</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                            |
| <b>Notes</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                            |
| (a)             | 1 <sup>st</sup> B1 for remainder of 1 <sup>st</sup> column probabilities (allow use of correct $p$ so 0.82)<br>2 <sup>nd</sup> B1 for remainder of 2 <sup>nd</sup> column probabilities (allow use of correct $q$ so 0.68 and 0.32)<br><b>In (b) or (c) if <math>p</math> or <math>q</math> are used as ft in M or A marks they must be probabilities</b>                                                                                                                                                                                                                                                                                                                                                                                                                   |                                            |
| (b)             | 1 <sup>st</sup> M1 for attempt to form eq'n in $p$ and $q$ using $P(T) = 0.169$ [at least 2 of 3 correct prod's]<br>1 <sup>st</sup> A1 for a fully correct equation in $p$ and $q$ or possibly just $q$ (using their $p$ see 3 <sup>rd</sup> M1)<br>2 <sup>nd</sup> M1 for use of a conditional prob (ratio of probabilities with num or den correct, allow ft on num) and $\frac{41}{169}$ to form an equation in $p$<br>2 <sup>nd</sup> A1ft for a correct equation using values from their tree diagram<br>3 <sup>rd</sup> A1 for solving to get $p = 0.16$ (or exact equivalent)<br>3 <sup>rd</sup> dM1 (dep on 1 <sup>st</sup> M1) for substituting their $p$ into an equation for $q$ (ft their $p$ value)<br>4 <sup>th</sup> A1 for $q = 0.68$ (or exact equivalent) |                                            |
| (c)(i)          | M1 for an attempt at a conditional prob with numerator of their $pq$ (num < denom)<br>1 <sup>st</sup> A1ft for a correct ratio of probs (ft their values for $p$ or $q$ with at least one correct)<br>2 <sup>nd</sup> A1 for awrt 0.726 (or exact fraction $\frac{544}{749}$ )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                            |
| (ii)            | B1 If (c)(i) < 0.7 then B0 for suggesting test <u>should be useful</u> (accept "yes") plus statement: about increased prob <u>or</u> "more likely to have type $A$ than no disease" <u>or</u> "prob of $A$ is high"                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                            |



| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Marks                   |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| 4. (a)          | $[W = \text{weight of a package delivered to Susie } W \sim N(510, 45^2)]$<br>$P(W < 450) = P\left(Z < \frac{450 - 510}{45}\right) \text{ or } P(Z < -1.3333)$<br>$= 1 - 0.9082$<br>$= 0.0918$ <b><u>0.0912~0.0918</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | M1<br>M1<br>A1<br>(3)   |
| (b)             | $[P(W > d) = 0.05 \text{ implies}] \quad \frac{d - 510}{45} = 1.6449$<br>$d = 584.0205\dots$ awrt <b><u>584</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | M1B1<br>A1<br>(3)       |
| (c)             | $[P(W > 450 \mid W < "584.02\dots") =] \quad \frac{P(450 < W < "584.02\dots")}{P(W < "584.02\dots")}$<br>$= \frac{0.95 - "0.0918"}{0.95} \text{ or } \frac{"0.9082" - 0.05}{0.95}$<br>$= 0.903368\dots$ awrt <b><u>0.904</u></b> or <b><u>0.903</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | M1<br>M1A1<br>A1<br>(4) |
| (d)             | $\left(\frac{19}{20}\right)^4 \times \frac{1}{20} \times 5$<br>$= 0.203626\dots$ awrt <b><u>0.204</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | M1dM1<br>A1<br>(3)      |
| <b>[13]</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |
| <b>Notes</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |
| <b>Ans only</b> | <p><b>Correct answer only in (a), (c) or (d) scores all the marks for that part</b></p> <p>(a) 1<sup>st</sup> M1 for standardising 450 with 510 and 45 (allow <math>\pm</math>)<br/> 2<sup>nd</sup> M1 for <math>1 - p</math> (where <math>0.90 &lt; p &lt; 0.99</math>)<br/> A1 for answer in the range 0.0912 to 0.0918 inclusive (calc. 0.09121133...)</p> <p>(b) M1 for standardising their letter <math>d</math> with 510 and 45 and setting equal to <math>z</math> value <math>1 &lt;  z  &lt; 2</math><br/> B1 for use of <math>z = \pm 1.6449</math> or better (calc 1.644853626...)<br/> A1 for awrt 584 (calc 584.0184...)<br/> [ awrt 584.02 scores 3/3 584 scores M1B0A1]</p> <p>(c) 1<sup>st</sup> M1 for a correct ratio of probability expressions ft their answer to (b) where (b) &gt; 450<br/> 2<sup>nd</sup> M1 for numerator of awrt 0.95 – their answer to (a)<br/> 1<sup>st</sup> A1 for a correct denominator of awrt 0.95 (dep on M1M1)<br/> NB a correct ratio of probabilities will score the 1<sup>st</sup> 3 marks<br/> 2<sup>nd</sup> A1 for awrt 0.904 or awrt 0.903</p> <p>(d) 1<sup>st</sup> M1 for <math>k p^4(1 - p)</math> for any positive integer <math>k</math> and any probability <math>p</math> (allow <math>k = 1</math>)<br/> 2<sup>nd</sup> dM1 for <math>k = 5</math><br/> A1 for awrt 0.204</p> |                         |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Marks                                                                                                                                                                                          |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5. (a)          | $E(X) = -2p - p + 0 + \frac{1}{2} + 3p ; \quad = \frac{1}{2}$                                                                                                                                                                                                                                                                                                                                                                                                                                                     | M1 ; A1<br>(2)                                                                                                                                                                                 |
| (b)             | $E(X^2) = 4p + p + 0 + 1 + 9p = [14p + 1]$<br>$[Var(X) =] E(X^2) - [E(X)]^2 = 14p + 1 - (\frac{1}{2})^2$<br>So $14p + 0.75 = 2.5$<br>$p = \frac{1}{8}$                                                                                                                                                                                                                                                                                                                                                            | M1A1<br>dM1<br>M1<br>A1<br>(5)                                                                                                                                                                 |
| (c)             | Sum of probabilities = 1 implies $q = \frac{3}{8}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                | B1ft<br>(1)                                                                                                                                                                                    |
| (d)             | $P(\text{Amar wins}) = \text{e.g. } P(X_1 > 0) + P(X_1 < 0) \times P([X_1 + X_2] > 0 \mid X_1 < 0)$ <u>or</u><br>$P(X_1 = 2 \text{ or } 3) + P(X_1 = -2) \times P(X_2 = 3) + P(X_1 = -1) \times P(X_2 = 2 \text{ or } 3)$<br><u>Cases</u> $X_1 = -2$ and $X_2 = 3$ so probability = $p^2$<br>$X_1 = -1$ and $X_2 \geq 2$ so probability = $p(p + \frac{1}{4})$<br>Total probability = $p + 0.25 + p^2 + p(p + 0.25) = \frac{1}{8} + \frac{1}{4} + \frac{1}{64} + \frac{1}{64} + \frac{1}{32}$<br>$= \frac{7}{16}$ | M1<br>M1<br>A1ft<br>A1<br>(4)                                                                                                                                                                  |
| (e)             | [Although $E(X) > 0$ since] $P(\text{win}) < 0.5$<br>Amar should not play the game <u>or</u> “disagree”                                                                                                                                                                                                                                                                                                                                                                                                           | M1<br>A1<br>(2)                                                                                                                                                                                |
| <b>[14]</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                |
| <b>Notes</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                |
| (a)             | M1 for a correct expr'n for $E(X)$ in $p$ (at least 3 non-zero terms seen). May be implied by A1<br>A1 for $\frac{1}{2}$ (or exact equivalent e.g. $\frac{2}{4}$ or 0.5)                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                |
| (b)             | 1 <sup>st</sup> M1 for a correct expression for $E(X^2)$ (at least 3 non-zero terms). May be implied by A1<br>1 <sup>st</sup> A1 for $14p + 1$ or any fully correct expression in terms of $p$<br>2 <sup>nd</sup> dM1 dep on 1 <sup>st</sup> M1 for use of $[Var(X) =] E(X^2) - [E(X)]^2$<br>3 <sup>rd</sup> M1 for forming a linear equation in $p$ using the 2.5<br>2 <sup>nd</sup> A1 for $p = \frac{1}{8}$ or exact equivalent e.g. 0.125                                                                     | If they think $E(X^2) = Var(X)$ get $p = \frac{3}{28}, q = \frac{3}{7}$ and up to (b) M1A1M0M1A0 (c) B1ft and if they get $\frac{319}{784}$ in (d) it implies M1M1A1A0 there and access to (e) |
| (c)             | B1ft for $q = \frac{3}{8}$ or exact equivalent e.g. 0.375 <u>or</u> $\frac{3}{4} - 3p$ $0 < p < 1$                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                |
| (d)             | 1 <sup>st</sup> M1 for identifying only the correct cases (any correct list, adding not needed)<br>2 <sup>nd</sup> M1 for identifying all the cases where a 2 <sup>nd</sup> spin is required <u>and</u> probabilities (no extras)<br>1 <sup>st</sup> A1ft for correct expression for total probability (allow their $0 < p < 1$ or letter $p$ )<br>2 <sup>nd</sup> A1 for $\frac{7}{16}$ (or exact equivalent e.g. 0.4375) [ $\frac{7}{16}$ with no incorrect working seen gets 4/4]                              |                                                                                                                                                                                                |
| ALT             | Allow $P(\text{loses}) = q + p(1 - p) + p(0.75 - p)$ only if $1 - P(\text{loses})$ is seen                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                |
| (e)             | M1 for identifying that the important feature is that $P(\text{win}) < 0.5$ (o.e.) [ft their $\frac{7}{16} < 0.5$ ]<br>A1cao for concluding that he shouldn't play the game (dep on M1 seen & $0.375 < (d) < 0.5$ )                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                      | Marks                       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| 6. (a)          | $\left[ \sum y = 16 \times 20.5 = 328 \right] \quad S_{yy} = 8266 - \frac{328^2}{16}$ $= 1542 \quad (\text{allow awrt } 1540)$ $[r =] \frac{-630.9}{\sqrt{368.16 \times 1542}}$ $= -0.837336... \quad \text{awrt } \underline{-0.837}$                                                                                                                                                                                                      | M1<br>A1<br>M1<br>A1<br>(4) |
| (b)             | As the distance from the hospital increases the percentage of referrals decreases (o.e.) e.g. smaller % of patients attend from clinics further away                                                                                                                                                                                                                                                                                        | B1<br>(1)                   |
| (c)             | e.g. Points close to a straight line (of negative gradient) so <u>does</u> support belief                                                                                                                                                                                                                                                                                                                                                   | B1<br>(1)                   |
| (d)             | $b = \frac{-630.9}{368.16} \quad [= -1.7136...]$ $a = 20.5 - (-1.7136...) \times 8.1 \quad [= 34.3806...]$ $y = 34.38... - 1.7136...x \quad \underline{y = 34.4 - 1.71x}$                                                                                                                                                                                                                                                                   | M1<br>M1<br>A1, A1<br>(4)   |
| (e)             | [On average] each km further from the hospital reduces the % attendance by 1.7%                                                                                                                                                                                                                                                                                                                                                             | B1<br>(1)                   |
| (f)             | Correct line drawn on scatter diagram (use overlay within guidelines)                                                                                                                                                                                                                                                                                                                                                                       | B1<br>(1)                   |
| (g)             | Correct point circled (3.2,19)<br>[Allow coords stated instead of point circled but if both, prioritise circled point]                                                                                                                                                                                                                                                                                                                      | B1<br>(1)                   |
| <b>[13]</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                             |                             |
| <b>Notes</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |                             |
| (a)             | 1 <sup>st</sup> M1 for an attempt at a correct expression for $S_{yy}$ (ft their 328 provided intention is $\Sigma y$ )<br>1 <sup>st</sup> A1 for 1542 (allow awrt 1540 it leads to $r = -0.83788...$ and scores 2 <sup>nd</sup> A0)<br>2 <sup>nd</sup> M1 for a correct expression for $r$ (ft their $S_{yy}$ but use of 8266 is M0 here)<br>2 <sup>nd</sup> A1 for awrt $-0.837$ (ans only 4/4; awrt $-0.838$ M1A1M1A0; $-0.84$ M1A0M1A0) |                             |
| (b)             | B1 for an interpretation of negative correlation <u>in context</u> (just “strong neg correlation” B0)                                                                                                                                                                                                                                                                                                                                       |                             |
| (c)             | B1 for “points close to a straight line” <u>and</u> stating does support manager’s belief<br><u>or</u> allow “ $r$ is close to $-1$ ” <u>or</u> “strong (negative) correlation” <u>and</u> supports manager’s claim<br><u>or</u> for a curve drawn on scatter diagram <u>and</u> comment that non-linear model may be better                                                                                                                |                             |
| (d)             | 1 <sup>st</sup> M1 for a correct expression for $b$<br>2 <sup>nd</sup> M1 for a correct expression for $a$ (ft their value of $b$ or even letter $b$ in correct formula)<br>1 <sup>st</sup> A1 (dep on 1 <sup>st</sup> M1) for $b =$ awrt $-1.71$ in an equation in $y$ and $x$ (no fractions)<br>2 <sup>nd</sup> A1 (dep on 2 <sup>nd</sup> M1) for $a =$ awrt $34.4$ in an equation in $y$ and $x$                                        |                             |
| (e)             | B1 for a comment with their $b$ ( $<0$ ) relating distance from hospital to % attendance/referrals<br>Allow “as distance increases by 1 the % referrals decreases by 1.7” (o.e.)                                                                                                                                                                                                                                                            |                             |
| (f)             | B1 for drawing the line on scatter diagram (within guidelines of overlay-check both graphs)                                                                                                                                                                                                                                                                                                                                                 |                             |
| (g)             | B1 for correct point on scatter diagram circled (more than one point circled is B0)                                                                                                                                                                                                                                                                                                                                                         |                             |

