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INTERNATIONAL A LEVEL MATHEMATICS • STATISTICS 1

# Statistics 1

Exam Questions by Topic: Mark Scheme

Pearson Edexcel International Advanced Level (WST01/01) • Calculator and Statistical Tables allowed

Every question in the booklet, marked line by line the way an examiner marks it

| Chapters (tap a chapter to jump to it)                                                                             | Qs | Marks | Page           | My score |
|--------------------------------------------------------------------------------------------------------------------|----|-------|----------------|----------|
| <b>1 Mathematical Modelling</b><br>Not examined on its own: modelling ideas are tested within Chapters 2 to 7      | —  | —     | Not applicable |          |
| <b>2 Measures of Location and Spread</b><br>Averages, quartiles, interpolation, standard deviation, coding         | 10 | 83    | own PDF        |          |
| <b>3 Representations of Data</b><br>Histograms, stem and leaf, box plots, outliers, skewness, comparisons          | 10 | 80    | own PDF        |          |
| <b>4 Probability</b><br>Venn and tree diagrams, conditional probability, independence                              | 10 | 80    | own PDF        |          |
| <b>5 Correlation and Regression</b><br>PMCC, least squares regression, interpretation, coding                      | 10 | 84    | 3              |          |
| <b>6 Discrete Random Variables</b><br>Probability and cumulative distributions, $E(X)$ , $\text{Var}(X)$ , uniform | 10 | 82    | own PDF        |          |
| <b>7 The Normal Distribution</b><br>Standardising, tables, finding $\mu$ and $\sigma$ , conditional problems       | 10 | 83    | own PDF        |          |

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## How to use this mark scheme

The same marking rules Pearson examiners use for WST01.

**Mark every line, not just the answer.** Method marks are given for a correct method even when the final answer is wrong. If you lost marks, find the *first* line where your working differs from the scheme. That is the thing to fix.

| Code       | Meaning                                                                                                                       |
|------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>M1</b>  | Method mark: for knowing a correct method and attempting to apply it. Small slips in the working do not lose this mark.       |
| <b>dM1</b> | Dependent method mark: can only be given if the method mark before it has been given.                                         |
| <b>A1</b>  | Accuracy mark: for a correct answer or line of working. It can only be given if the method mark it depends on has been given. |
| <b>B1</b>  | Independent mark: for a correct result or statement, whatever method was used.                                                |
| <b>*</b>   | The answer is given in the question. Every step must be shown, and the answer must follow from correct working (cso).         |
| <b>cao</b> | Correct answer only.                                                                                                          |
| <b>cso</b> | Correct solution only: no errors anywhere in the working.                                                                     |
| <b>ft</b>  | Follow through: the mark can be given for correct work using your own earlier (wrong) answer.                                 |
| <b>oe</b>  | Or equivalent: any correct equivalent form is accepted.                                                                       |

**“Solutions relying on calculator technology are not acceptable.”** When a question says this, a correct final answer with no algebraic working scores **no marks**. The notes under each scheme line say when this applies.



## 5

## Chapter 5: Correlation and Regression

Mark scheme. Marks are shown on the right of each line.

## Question 1

5 marks

| Part                          | Scheme                                           | Marks |
|-------------------------------|--------------------------------------------------|-------|
| (a)                           | $S_{xx} = 385 - \frac{55^2}{10} = 82.5$          | B1    |
|                               | $S_{yy} = 10650 - \frac{320^2}{10} = 410$        | B1    |
|                               | $S_{xy} = 1920 - \frac{55 \times 320}{10} = 160$ | B1    |
|                               |                                                  | (3)   |
| (b)                           | $\frac{160}{\sqrt{82.5 \times 410}}$             | M1    |
|                               | 0.870                                            | A1    |
|                               |                                                  | (2)   |
| Total for Question 1: 5 marks |                                                  |       |

## Question 2

5 marks

| Part                          | Scheme                                                       | Marks |
|-------------------------------|--------------------------------------------------------------|-------|
| (a)                           | $b = \frac{96}{40} = 2.4$                                    | B1    |
|                               | $a = 20 - 2.4 \times 6 = 5.6$                                | M1    |
|                               | $y = 5.6 + 2.4x$                                             | A1    |
|                               |                                                              | (3)   |
| (b)                           | 22.4                                                         | B1    |
|                               |                                                              | (1)   |
| (c)                           | 25 is outside the range of the data (2 to 10): extrapolation | B1    |
|                               |                                                              | (1)   |
| Total for Question 2: 5 marks |                                                              |       |



## Question 3

5 marks

| Part                          | Scheme                                                                                              | Marks     |
|-------------------------------|-----------------------------------------------------------------------------------------------------|-----------|
| (a)                           | Strong positive correlation: students who revise for more hours tend to get higher test scores      | B1<br>(1) |
| (b)                           | Hours of revision, since the test score depends on it                                               | B1<br>(1) |
| (c)                           | Correlation does not show causation: other factors (e.g. ability) could explain the scores          | B1<br>(1) |
| (d)                           | Very weak negative (almost no) linear correlation between revision time and score                   | B1<br>(1) |
| (e)                           | It only measures <i>linear</i> correlation (or: it is affected by outliers; it does not show cause) | B1<br>(1) |
| Total for Question 3: 5 marks |                                                                                                     |           |

## Question 4

5 marks

| Part                          | Scheme                                                                            | Marks                         |
|-------------------------------|-----------------------------------------------------------------------------------|-------------------------------|
| (a)                           | 0.72                                                                              | B1<br>(1)                     |
| (b)                           | $\frac{y}{10} = 2.1 + 0.35(x - 100)$<br>$y = 21 + 3.5x - 350$<br>$y = 3.5x - 329$ | M1<br><br>M1<br><br>A1<br>(3) |
| (c)                           | For each increase of 1 in $x$ , $y$ increases by 3.5 (on average)                 | B1<br>(1)                     |
| Total for Question 4: 5 marks |                                                                                   |                               |



## Question 5

5 marks

| Part                                 | Scheme                                                                                                                                                                                                                                   | Marks               |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| (a)                                  | For each extra employee, spending increases by 0.156 thousand dollars<br>i.e. by <span style="border: 1px solid green; padding: 2px;">\$156</span> per month<br><br><i>\$0.156 or \$1.56 scores M1 A0: c is in thousands of dollars.</i> | M1<br>A1<br><br>(2) |
| (b)                                  | $12.5 + 0.156 \times 80 = 24.98$<br><br><span style="border: 1px solid green; padding: 2px;">\$24 980</span>                                                                                                                             | M1<br>A1<br>(2)     |
| (c)                                  | $p = 0$ is outside the range of the data (20 to 120), so this is extrapolation                                                                                                                                                           | B1<br>(1)           |
| <b>Total for Question 5: 5 marks</b> |                                                                                                                                                                                                                                          |                     |



## Question 6

13 marks

| Part                           | Scheme                                                                                                                                                                       | Marks                       |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| (a)                            | $S_{tg} = 5160 - \frac{168 \times 235}{8} = 225 \quad *$ $S_{tt} = 168$ $S_{gg} = 341.875$                                                                                   | B1*<br>B1<br>B1<br>(3)      |
| (b)                            | $\frac{225}{\sqrt{168 \times 341.875}}$ $0.939$                                                                                                                              | M1<br>A1<br>(2)             |
| (c)                            | Strong positive correlation: on hotter days the café tends to sell more ice creams                                                                                           | B1<br>(1)                   |
| (d)                            | $b = \frac{225}{168} = 1.339 \dots$ $\bar{t} = 21, \bar{g} = 29.375$ $a = 29.375 - 1.339 \dots \times 21 = 1.25$ $g = 1.25 + 1.34t$                                          | M1<br>B1<br>M1<br>A1<br>(4) |
| (e)                            | For each 1 °C rise, about 13 (1.34 tens) more ice creams are sold<br><br><i>The unit "tens" must be used: "1.34 more ice creams" scores B0.</i>                              | B1<br>(1)                   |
| (f)                            | (i) $1.25 + 1.339 \dots \times 25 = 34.7$ tens, i.e. <b>about 347 ice creams</b><br>(ii) Unreliable: 40 °C is outside the range of temperatures (14 to 28 °C), extrapolation | B1<br>B1<br>(2)             |
| Total for Question 6: 13 marks |                                                                                                                                                                              |                             |



## Question 7

11 marks

| Part                           | Scheme                                                                                                                                                                                                                                                                                             | Marks                            |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| (a)                            | $\frac{11\,670}{\sqrt{586 \times 234\,889}}$ <div>0.995</div>                                                                                                                                                                                                                                      | M1<br>A1<br>(2)                  |
| (b)                            | $b = \frac{11\,670}{586} = 19.914\dots$ $\bar{L} = 35 \text{ and } \bar{m} = 431.11\dots$ $a = 431.11\dots - 19.914\dots \times 35 = -265.90\dots$ $m = -265.9 + 19.91L, \text{ so } m = -266 + 19.9L^*$ <p><i>Values to one more figure than those given must be seen for the final mark.</i></p> | M1<br>B1<br>M1<br>A1*<br><br>(4) |
| (c)                            | 0.36 m = 36 cm: $-266 + 19.9 \times 36$<br><div>450 g</div> (451 using the unrounded line)<br><p><i>Substituting <math>L = 0.36</math> gives a negative mass: M0.</i></p>                                                                                                                          | M1<br>A1<br><br>(2)              |
| (d)                            | The line gives $m = -67$ (a negative mass), which is impossible<br>10 cm is outside the range of lengths (22 to 48 cm), so the linear model may not hold                                                                                                                                           | B1<br>B1<br>(2)                  |
| (e)                            | Each extra cm of length adds about 19.9 g to the mass                                                                                                                                                                                                                                              | B1<br>(1)                        |
| Total for Question 7: 11 marks |                                                                                                                                                                                                                                                                                                    |                                  |



## Question 8

13 marks

| Part                           | Scheme                                                                          | Marks     |
|--------------------------------|---------------------------------------------------------------------------------|-----------|
| (a)                            | $S_{xx} = 55 - \frac{15^2}{6} = 17.5$                                           | B1        |
|                                | $S_{yy} = 371.9 - \frac{41^2}{6} = 91.73$                                       | B1        |
|                                | $S_{xy} = 141.8 - \frac{15 \times 41}{6} = 39.3$                                | B1        |
|                                |                                                                                 | (3)       |
| (b)                            | $\frac{39.3}{\sqrt{17.5 \times 91.73 \dots}}$                                   | M1        |
|                                | 0.981                                                                           | A1<br>(2) |
| (c)                            | 0.981: linear coding does not change the correlation coefficient                | B1<br>(1) |
| (d)                            | $b = \frac{39.3}{17.5} = 2.245 \dots$                                           | M1        |
|                                | $a = \frac{41}{6} - 2.245 \dots \times \frac{15}{6} = 1.219 \dots$              | M1        |
|                                | $y = 1.22 + 2.25x$                                                              | A1        |
|                                |                                                                                 | (3)       |
| (e)                            | $\frac{p - 200}{10} = 1.219 \dots + 2.245 \dots \times \frac{t - 2000}{4}$      | M1        |
|                                | $p = 212 + 5.61(t - 2000)$                                                      | A1<br>(2) |
| (f)                            | $212.19 + 5.614 \times 30 = \text{£}381$                                        | B1        |
|                                | Unreliable: 2030 is outside the years in the data (2000 to 2020), extrapolation | B1        |
|                                |                                                                                 | (2)       |
| Total for Question 8: 13 marks |                                                                                 |           |



## Question 9

10 marks

| Part                           | Scheme                                                                                                                                                      | Marks                 |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| (a)                            | $\frac{1350}{\sqrt{2250 \times 1200}}$<br>0.822                                                                                                             | M1<br>A1<br>(2)       |
| (b)                            | $b = \frac{1350}{2250} = 0.6$<br>$a = 130 - 0.6 \times 45$<br>$s = 103 + 0.6a$                                                                              | B1<br>M1<br>A1<br>(3) |
| (c)                            | Blood pressure rises by about 0.6 mmHg for each extra year of age                                                                                           | B1<br>(1)             |
| (d)                            | $0.6x = 9$<br>15 years<br><i>Substituting <math>s = 9</math> into the whole equation is the common error: it is the change in <math>s</math> that is 9.</i> | M1<br>A1<br>(2)       |
| (e)                            | The line of $s$ on $a$ predicts $s$ from $a$ ; estimating $a$ needs the regression line of $a$ on $s$ (age is the explanatory variable)                     | B1<br>(1)             |
| (f)                            | Correlation does not imply causation (other factors, e.g. lifestyle, may be involved)                                                                       | B1<br>(1)             |
| Total for Question 9: 10 marks |                                                                                                                                                             |                       |



## Question 10

12 marks

| Part                                   | Scheme                                                                                                                                                                                                                                                                                                                    | Marks                 |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| (a)                                    | $S_{xx} = 440 - 360 = 80$ , $S_{yy} = 13\,050 - 12\,250 = 800$ , $S_{xy} = 2280 - 2100 = 180$<br>$\frac{180}{\sqrt{80 \times 800}}$ <span style="border: 1px solid green; padding: 2px;">0.712</span>                                                                                                                     | M1<br>M1<br>A1<br>(3) |
| (b)                                    | <span style="border: 1px solid green; padding: 2px;"><math>\sum y = 365</math></span><br><span style="border: 1px solid green; padding: 2px;"><math>\sum y^2 = 13\,050 - 900 + 2025 = 14\,175</math></span><br><span style="border: 1px solid green; padding: 2px;"><math>\sum xy = 2280 - 240 + 360 = 2400</math></span> | B1<br>B1<br>B1<br>(3) |
| (c)                                    | $S_{yy} = 14\,175 - \frac{365^2}{10} = 852.5$ and $S_{xy} = 2400 - \frac{60 \times 365}{10} = 210$<br>$\frac{210}{\sqrt{80 \times 852.5}} = \text{0.804}$ <p>The correlation is stronger (0.804 compared with 0.712)</p>                                                                                                  | M1<br>A1<br>B1<br>(3) |
| (d)                                    | $b = \frac{210}{80} = 2.625$<br>$a = 36.5 - 2.625 \times 6 = 20.75$<br><span style="border: 1px solid green; padding: 2px;"><math>y = 20.8 + 2.63x</math></span>                                                                                                                                                          | M1<br>M1<br>A1<br>(3) |
| <b>Total for Question 10: 12 marks</b> |                                                                                                                                                                                                                                                                                                                           |                       |

