S1 Correlation and Regression: exam questions

10 questions · 23 marks · full mark schemes

Name _____ Date _____ Score / 23

- Product-moment correlation coefficient (PMCC), scatterplots, least-squares regression line y on x.
- Try every question before you look at the mark schemes. They start after the questions: M marks for method, A marks for accuracy, B marks for a correct result on its own.
- Online, with more practice: alevelmathrevision.com/alevel-frontend/units/s1/correlation-regression-questions

1. **2 marks · warm-up**

Calculate the gradient, b, of the regression line of y on x, given that $S_{xy} = 125$ and $S_{xx} = 50$.

2. **2 marks · warm-up**

The regression line $y = 15 + 2.4x$ was created using advertising spend data ranging from $x = 5$ to $x = 25$. Predict the sales when the advertising spend is £2000 ($x = 20$).

3. **2 marks · standard**

For a dataset of 12 pairs of values, $\sum x = 60$, $\sum y = 84$, and $\sum xy = 350$. Calculate the value of S_{xy}.

4. 2 marks · standard

Given that $S_{xx} = 40$, $S_{yy} = 85$, and $S_{xy} = 52$, calculate the product moment correlation coefficient, r, to 3 significant figures.

5. 2 marks · standard

A regression line of y on x has the equation $y = a + bx$. Given that the gradient $b = 1.4$, the mean of x is 4.5, and the mean of y is 12.8, calculate the value of a.

6. 2 marks · standard

The regression line of y on x for the sales of a product (y, in thousands) based on advertising spend (x, in hundreds of pounds) is $y = 15 + 2.4x$. Interpret the meaning of the value 2.4 in this context.

7. 2 marks · harder

Using the coding $u = \frac{x}{2}$ and $v = y - 5$, it is found that $S_{uu} = 20$. Find the value of S_{xx}.

8. 3 marks · harder

Data is modelled using the function $y = ax^n$. A plot of $\log_{10} y$ against $\log_{10} x$ gives a straight line with gradient 2.5 and y-intercept 1.2. Find the values of the constants a and n.

9. 3 marks · harder

Data pairs (x, y) are coded using $u = \frac{x}{2}$ and $v = y - 5$. Given that $S_{uv} = 45$, find the value of S_{xy}.

10. 3 marks · harder

A regression line for coded data u and v is calculated as $v = 4 + 1.5u$. If $u = x - 10$ and $v = y + 5$, find the equation of the regression line of y on x.

Answers and worked solutions

Question 1

2 marks

1. M1 for using the formula $b = \frac{S_{xy}}{S_{xx}}$.
2. A1 for finding $b = \frac{125}{50} = 2.5$.

Question 2

2 marks

1. M1 for substituting $x = 20$ into the regression equation: $15 + 2.4(20)$.
2. A1 for finding the predicted sales are 63 thousand.

Question 3

2 marks

1. M1 for applying the formula $S_{xy} = \sum xy - \frac{\sum x \sum y}{n}$.
2. A1 for evaluating $350 - \frac{60 \times 84}{12} = 350 - 420 = -70$.

Question 4

2 marks

1. M1 for applying the formula $r = \frac{S_{xy}}{\sqrt{S_{xx} S_{yy}}}$.
2. A1 for calculating $r = \frac{52}{\sqrt{40 \times 85}} = 0.89179\ldots = 0.892$ (3 s.f.).

Question 5

2 marks

1. M1 for using the formula $a = \bar{y} - b\bar{x}$.
2. A1 for $a = 12.8 - 1.4(4.5) = 12.8 - 6.3 = 6.5$.

Question 6

2 marks

Answer: Each extra £100 of advertising is associated with 2400 more sales

1. M1 for identifying it as the rate of change.
2. A1 for stating: For every extra £100 spent on advertising, the sales of the product increase by 2.4 thousand (or 2400).

Question 7

2 marks

1. M1 for applying the scaling relationship $S_{uu} = (\frac{1}{2})^2 S_{xx} = \frac{1}{4} S_{xx}$.
2. A1 for calculating $S_{xx} = 4 \times 20 = 80$.

Question 8

3 marks

1. M1 for equating the gradient to n: $n = 2.5$.
2. M1 for equating the intercept to $\log_{10} a$: $\log_{10} a = 1.2$.
3. A1 for calculating $a = 10^{1.2} \approx 15.8$.

Question 9

3 marks

1. M1 for writing the relationship between the coded differences: $u_i - \bar{u} = \frac{1}{2}(x_i - \bar{x})$.
2. M1 for recognising that $v_i - \bar{v} = (y_i - 5) - (\bar{y} - 5) = y_i - \bar{y}$.
3. A1 for deducing that $S_{uv} = \frac{1}{2} S_{xy}$, so $S_{xy} = 2 \times 45 = 90$.

Question 10

3 marks

1. M1 for substituting the original variables back into the line equation: $(y + 5) = 4 + 1.5(x - 10)$.
2. M1 for expanding the expression correctly: $y + 5 = 4 + 1.5x - 15$.
3. A1 for simplifying to the final equation $y = -16 + 1.5x$.

More correlation and regression practice with instant feedback: alevelmathrevision.com/alevel-frontend/units/s1/correlation-regression-questions

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