4.20 Scatter Graphs: Test Pack

EDEXCEL 1MA1 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A scatter graph is drawn for two variables. As the value of one variable increases, the value of the other variable tends to decrease. State the type of correlation shown.

(Total for Question 1 is 1 mark)

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2 A scatter graph shows data for values of x from 3 to 20. Jo uses the line of best fit to estimate y when x = 29.
Is Jo's estimate likely to be reliable? Give a reason.

(Total for Question 2 is 2 marks)

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3 State one feature of a good line of best fit drawn on a scatter graph.

(Total for Question 3 is 1 mark)

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4 For each statement, write True or False.

(a) A scatter graph showing a strong positive correlation between two variables proves that one variable causes the other to increase. **(1)**

(b) It is possible for two variables to show a strong correlation even though there is no causal link between them. **(1)**

(c) A line of best fit can be used to make a reliable estimate for any value of x, no matter how large. **(1)**

(Total for Question 4 is 3 marks)

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5 A personal trainer records the height (cm) and weight (kg) of 8 gym members. Height in cm (x): 160, 165, 168, 170, 172, 175, 178, 190. Weight in kg (y): 55, 60, 63, 66, 68, 70, 73, 64.

(a) Write down the coordinates of the outlier and suggest a possible reason why this data point does not fit the trend. **(2)**

(b) Calculate the mean height and the mean weight of the remaining 7 members, excluding the outlier. **(2)**

(c) Explain how removing the outlier would affect the line of best fit. **(1)**

(Total for Question 5 is 5 marks)

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6 A courier company records parcel weight and delivery cost. A line of best fit has been drawn passing through (2, 4) and (10, 20), where x is weight in kg and y is cost in pounds.

(a) Use the line of best fit to estimate the cost of delivering a parcel weighing 6 kg. **(2)**

(b) The company's official price list charges a flat fee of £2 plus £1.60 per kg. Calculate the cost for a 6 kg parcel using the price list, and compare this with your answer to part (a). **(2)**

(Total for Question 6 is 4 marks)

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7 A charity records distance walked in a sponsored walk (x in km) and money raised (y in pounds) for 9 participants: (1, 10), (2, 18), (3, 25), (4, 34), (5, 39), (6, 45), (7, 48), (8, 54), (9, 57).

(a) Describe the correlation in one short sentence. **(1)**

(b) Estimate money raised for x = 5.5 km using a sensible line of best fit. **(4)**

(c) A participant walked 0.5 km and raised £2. Is this consistent with the trend? Give a short reason. **(2)**

(d) Explain briefly how you would draw a line of best fit on this scatter diagram. **(2)**

(Total for Question 7 is 9 marks)

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8 A car magazine investigates the relationship between a car's engine size, in litres, and its fuel economy, in miles per gallon, for 40 cars. The scatter graph shows moderate negative correlation, but the points are fairly scattered rather than lying close to a line.

(a) State what 'moderate negative correlation, but fairly scattered' tells you about the strength of the relationship between engine size and fuel economy. **(1)**

(b) A second magazine collects data on the same 40 cars, also recording each car's weight. They find that heavier cars tend to have both bigger engines and worse fuel economy. Explain how this new information affects the conclusion that a bigger engine directly causes worse fuel economy. **(2)**

(c) Suggest one other variable, apart from car weight, that a researcher could investigate to help explain a car's fuel economy. **(1)**

(Total for Question 8 is 4 marks)

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9 A spring is stretched by hanging different loads on it. The load x (newtons) and the total length y (cm) of the spring were recorded for loads between 2 N and 8 N: (2, 5), (4, 9), (6, 13), (8, 17).

(a) Show that the four points (2, 5), (4, 9), (6, 13), (8, 17) lie exactly on a straight line, and find its equation in the form $y = mx + c$. **(4)**

(b) Interpret the gradient and the y-intercept of this line in the context of the spring. **(2)**

(c) The manufacturer states the spring will break when its total length reaches 25 cm. Use the equation to find the load at which this would happen, and explain whether your answer involves interpolation or extrapolation. **(4)**

(d) A second, stiffer spring gives the data points (1, 3), (3, 6), (5, 9) for loads between 1 N and 5 N. Show that this data also lies exactly on a straight line, find its equation, and hence find the load at which both springs would have the same total length. Give the length of the springs at that load. **(6)**

(Total for Question 9 is 16 marks)

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Mark scheme · 4.20 Scatter Graphs: Test Pack

Question 1

negative correlation (oe) **B1**

Answer: Negative correlation

Question 2

compares 29 with the range of the data (3 to 20) **M1**

not reliable (extrapolation) **A1**

Answer: not reliable (extrapolation)

Question 3

any correct feature, e.g. it follows the trend of the points with roughly equal numbers of points above and below it (oe), or it passes through the mean point **B1**

Answer: It should follow the trend of the data with roughly equal numbers of points above and below the line.

Question 4

(a) False **B1**

(a) Answer: False

(b) True **B1**

(b) Answer: True

(c) False **B1**

(c) Answer: False

Question 5

(a) (190, 64) cao **B1**

(a) any sensible reason, e.g. the weight may have been recorded or measured incorrectly for this member (oe) **B1**

(a) Answer: (190, 64); the weight for this member may have been recorded incorrectly, since it does not fit the increasing trend.

(b) mean height = 169.7 cm (awrt, from 1188/7) **B1**

(b) mean weight = 65 kg cao (from 455/7) **B1**

(b) Answer: Mean height = 169.7 cm (1 d.p.), mean weight = 65 kg

(c) the line of best fit would fit the remaining points more closely, better reflecting the true positive trend, since it would no longer be pulled off course by the outlier **B1**

(c) Answer: Without the outlier, the line of best fit would follow the true positive trend more closely, as it would no longer be distorted by the anomalous point.

Question 6

(a) correct method, e.g. gradient = (20-4)/(10-2) = 2, then 4 + 2 x (6-2) **M1**

(a) £12 cao **A1**

(a) Answer: £12

(b) 2 + 1.60 x 6 **M1**

(b) £11.60, with a valid comparison, e.g. this is close to the £12 estimate from the scatter graph, showing the line of best fit gives a reasonable estimate **A1**

(b) Answer: £11.60, which is close to the £12 estimate from part (a) (a difference of only 40p).

Question 7

(a) positive correlation identified **B1**

(a) Answer: Positive correlation, fairly strong.

(b) use a sensible line of best fit (or interpolate between (5,39) and (6,45)) to find y at x = 5.5 **M1**

(b) read from the line or calculate at x = 5.5, e.g. midpoint 39 + 0.5*(45-39) = 42 **M1**

(b) state an estimate in pounds (42 by interpolation; accept a decimal or a rounded value) **M1**

(b) an estimate from £39 to £43 inclusive (£42 by interpolation between the neighbouring points; a straight line of best fit gives about £40 and a smooth curve about £42) **A1**

(b) Answer: Approximately £42 (accept any sensible estimate from £39 to £43)

(c) state whether consistent or not **M1**

(c) reason: point lies below expected trend but near extrapolated low values so could be consistent but shows lower fundraising per km; accept reasonable justification **A1**

(c) Answer: It is slightly low compared with the trend but could be consistent for very small distances; it lies below the line of best fit so it is lower than expected.

(d) state method: draw a straight line that has roughly equal numbers of points above and below it and follows the overall trend **M1**

(d) mention minimizing distances or that the line should reflect the general trend, not through all points; accept 'eye-fit' explanation **A1**

(d) Answer: Draw a straight line that follows the overall trend and has roughly equal numbers of points above and below it; do not try to pass through every point.

Question 8

(a) there is a genuine negative relationship (bigger engines tend to go with worse fuel economy), but it is not a strong or highly reliable one, since the points are not tightly clustered around a line (oe) **B1**

(a) Answer: There is a real negative link between engine size and fuel economy, but it is not very strong, since the points are quite spread out rather than close to a line.

(b) identifies car weight as a third factor (confounding variable) linked to both engine size and fuel economy **B1**

(b) explains that this means engine size may not be the only, or even the main, direct cause of worse fuel economy, since the apparent link could partly or wholly be explained by weight (oe) **B1**

(b) Answer: Car weight could be causing both a bigger engine and worse fuel economy, so it is a confounding variable; this means the original conclusion that engine size directly causes worse fuel economy is weakened, since weight might explain some or all of the pattern instead.

(c) any sensible variable other than weight, e.g. driving style/average speed, tyre type, aerodynamic design, or fuel type (oe) **B1**

(c) Answer: For example, the driving style or average speed of the car's usual driver.

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Question 9

(a) gradient using (2,5) and (4,9): (9-5)/(4-2) = 2 **M1**

(a) use (2,5) to find intercept: 5 = 2*2 + c, so c = 1, giving y = 2x + 1 **A1**

(a) check (6,13): 2*6 + 1 = 13, which matches **M1**

(a) check (8,17): 2*8 + 1 = 17, which matches, so all four points lie exactly on y = 2x + 1 cao **A1**

(a) Answer: y = 2x + 1; all four points lie exactly on this line.

(b) gradient = 2 means the spring stretches by an extra 2 cm for every extra 1 N of load applied **M1**

(b) y-intercept = 1 means the spring's natural (unloaded) length is 1 cm, when x = 0 oe **A1**

(b) Answer: Gradient 2: the length increases by 2 cm for each extra newton of load. Intercept 1: the spring's natural length (with no load) is 1 cm.

(c) set 25 = 2x + 1 and rearrange **M1**

(c) x = 12 N cao **A1**

(c) state the original data only covers loads from 2 N to 8 N **M1**

(c) conclude x = 12 N is outside this range, so this is extrapolation and the prediction may be unreliable (e.g. the spring may not obey the same linear relationship close to breaking point) oe **A1**

(c) Answer: x = 12 N. This is extrapolation, since 12 N is outside the original data range of 2 N to 8 N, so the prediction may not be reliable.

(d) gradient using (1,3) and (3,6): (6-3)/(3-1) = 1.5 **M1**

(d) use (1,3) to find intercept: 3 = 1.5*1 + c, so c = 1.5, giving y = 1.5x + 1.5 **A1**

(d) check (5,9): 1.5*5 + 1.5 = 9, which matches, so all three points lie exactly on this line **M1**

(d) set the two spring equations equal: 2x + 1 = 1.5x + 1.5 **M1**

(d) x = 1.0 N cao **A1**

(d) corresponding length y = 2(1) + 1 = 3 cm, so both springs are 3 cm long when the load is 1.0 N cao **A1**

(d) Answer: Second spring: y = 1.5x + 1.5. Both springs have the same length (3 cm) when the load is 1.0 N.

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