

AI SL 13.09 [63 marks]

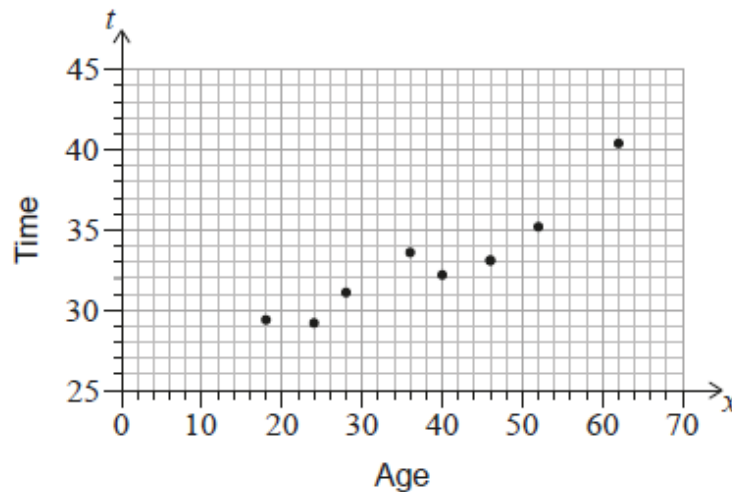
1. [Maximum mark: 6]

21N.1.SL.TZ0.1

Eduardo believes that there is a linear relationship between the age of a male runner and the time it takes them to run 5000 metres.

To test this, he recorded the age,  $x$  years, and the time,  $t$  minutes, for eight males in a single 5000 m race. His results are presented in the following table and scatter diagram.

<b><math>x</math>, years</b>	18	24	28	36	40	46	52	62
<b><math>t</math>, minutes</b>	29.4	29.2	31.1	33.6	32.2	33.1	35.2	40.4



- (a) For this data, find the value of the Pearson's product-moment correlation coefficient,  $r$ .

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Eduardo looked in a sports science text book. He found that the following information about  $r$  was appropriate for athletic performance.

Value of $ r $	Description of the correlation
$0 \leq  r  < 0.4$	weak
$0.4 \leq  r  < 0.8$	moderate
$0.8 \leq  r  \leq 1$	strong

(b) Comment on your answer to part (a), using the information that Eduardo found.

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(c) Write down the equation of the regression line of  $t$  on  $x$ , in the form  $t = ax + b$ .

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(d) A 57-year-old male also ran in the 5000 m race.

Use the equation of the regression line to estimate the time he took to complete the 5000 m race.

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2. [Maximum mark: 6]

20N.2.SL.TZ0.S\_2

Lucy sells hot chocolate drinks at her snack bar and has noticed that she sells more hot chocolates on cooler days. On six different days, she records the maximum daily temperature,  $T$ , measured in degrees centigrade, and the number of hot chocolates sold,  $H$ . The results are shown in the following table.

<b>Maximum temperature (<math>T</math>)</b>	14	8	4	18	13	11
<b>Number of hot chocolates (<math>H</math>)</b>	79	143	191	58	84	105

The relationship between  $H$  and  $T$  can be modelled by the regression line with equation  $H = aT + b$ .

(a.i) Find the value of  $a$  and of  $b$ .

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(a.ii) Write down the correlation coefficient.

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(b) Using the regression equation, estimate the number of hot chocolates that Lucy will sell on a day when the maximum temperature is  $12^{\circ}\text{C}$ .

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3. [Maximum mark: 6]

19N.1.SL.TZ0.T\_6

Galois Airways has flights from Hong Kong International Airport to different destinations. The following table shows the distance,  $x$  kilometres, between Hong Kong and the different destinations and the corresponding airfare,  $y$ , in Hong Kong dollars (HKD).

Destination	Bali, Indonesia	Sydney, Australia	Bengaluru, India	Singapore	Auckland, New Zealand	Bangkok, Thailand
Distance $x$ , (km)	3400	7400	4000	2600	9200	1700
Airfare $y$ , (HKD)	1550	3600	2800	1300	4000	1400

The Pearson's product-moment correlation coefficient for this data is 0.948, correct to three significant figures.

- (a) Use your graphic display calculator to find the equation of the regression line  $y$  on  $x$ .

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The distance from Hong Kong to Tokyo is 2900 km.

- (b) Use your regression equation to estimate the cost of a flight from Hong Kong to Tokyo with Galois Airways.

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(c) Explain why it is valid to use the regression equation to estimate the airfare between Hong Kong and Tokyo.

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4. [Maximum mark: 6]

19M.2.SL.TZ2.S\_1

A group of 7 adult men wanted to see if there was a relationship between their Body Mass Index (BMI) and their waist size. Their waist sizes, in centimetres, were recorded and their BMI calculated. The following table shows the results.

<b>Waist (<math>x</math> cm)</b>	58	63	75	82	93	98	105
<b>BMI (<math>y</math>)</b>	19	20	22	23	25	24	26

The relationship between  $x$  and  $y$  can be modelled by the regression equation  $y = ax + b$ .

(a.i) Write down the value of  $a$  and of  $b$ . [3]

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(a.ii) Find the correlation coefficient. [1]

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(b) Use the regression equation to estimate the BMI of an adult man whose waist size is 95 cm. [2]





5. [Maximum mark: 6]

18M.2.SL.TZ2.S\_1

The following table shows the mean weight,  $y$  kg, of children who are  $x$  years old.

<b>Age (<math>x</math> years)</b>	1.25	2.25	3.5	4.4	5.85
<b>Weight (<math>y</math> kg)</b>	10	13	14	17	19

The relationship between the variables is modelled by the regression line with equation  $y = ax + b$ .

(a.i) Find the value of  $a$  and of  $b$ . [3]

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(a.ii) Write down the correlation coefficient. [1]

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(b) Use your equation to estimate the mean weight of a child that is 1.95 years old. [2]



6. [Maximum mark: 17]

SPM.2.SL.TZ0.3

The Malvern Aquatic Center hosted a 3 metre spring board diving event. The judges, Stan and Minsun awarded 8 competitors a score out of 10. The raw data is collated in the following table.

Competitors	A	B	C	D	E	F	G	H
Stan's score ( $x$ )	4.1	3	4.3	6	7.1	6	7.5	6
Minsun's score ( $y$ )	4.7	4.6	4.8	7.2	7.8	9	9.5	7.2

(a.i) Write down the value of the Pearson's product-moment correlation coefficient,  $r$ .

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(a.ii) Using the value of  $r$ , interpret the relationship between Stan's score and Minsun's score.

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(b) Write down the equation of the regression line  $y$  on  $x$ .

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(c.i) Use your regression equation from part (b) to estimate Minsun's score when Stan awards a perfect 10. [2]

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(c.ii) State whether this estimate is reliable. Justify your answer. [2]

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The Commissioner for the event would like to find the Spearman's rank correlation coefficient.

(d) **Copy** and complete the information in the following table.

Competitors	A	B	C	D	E	F	G	H
Stan's Rank		8					1	4
Minsun's Rank		8					1	4.5

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(e.i) Find the value of the Spearman's rank correlation coefficient,  $r_s$ .

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(e.ii) Comment on the result obtained for  $r_s$ .

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(f) The Commissioner believes Minsun's score for competitor G is too high and so decreases the score from 9.5 to 9.1.

Explain why the value of the Spearman's rank correlation coefficient  $r_s$  does not change.

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7. [Maximum mark: 16]

22M.2.SL.TZ1.3

The scores of the eight highest scoring countries in the 2019 Eurovision song contest are shown in the following table.

	<b>Eurovision score</b>
<b>Netherlands</b>	498
<b>Italy</b>	472
<b>Russia</b>	370
<b>Switzerland</b>	364
<b>Sweden</b>	334
<b>Norway</b>	331
<b>North Macedonia</b>	305
<b>Azerbaijan</b>	302

For this data, find

(a.i) the upper quartile.

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(a.ii) the interquartile range.

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(b) Determine if the Netherlands' score is an outlier for this data.  
Justify your answer.

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Chester is investigating the relationship between the highest-scoring countries' Eurovision score and their population size to determine whether population size can reasonably be used to predict a country's score.

The populations of the countries, to the nearest million, are shown in the table.

	Population ( $x$ ) (millions)	Eurovision score ( $y$ )
<b>Netherlands</b>	17	498
<b>Italy</b>	60	472
<b>Russia</b>	145	370
<b>Switzerland</b>	9	364
<b>Sweden</b>	10	334
<b>Norway</b>	5	331
<b>North Macedonia</b>	2	305
<b>Azerbaijan</b>	10	302

Chester finds that, for this data, the Pearson's product moment correlation coefficient is  $r = 0.249$ .

- (c) State whether it would be appropriate for Chester to use the equation of a regression line for  $y$  on  $x$  to predict a country's Eurovision score. Justify your answer.

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Chester then decides to find the Spearman's rank correlation coefficient for this data, and creates a table of ranks.

	Population rank (to the nearest million)	Eurovision score rank
Netherlands	3	1
Italy	2	2
Russia	1	3
Switzerland	$a$	4
Sweden	$b$	5
Norway	7	6
North Macedonia	8	7
Azerbaijan	$c$	8

Write down the value of:

(d.i)  $a$ . [1]

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(d.ii)  $b$ . [1]

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(d.iii)  $c$ . [1]

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(e.i) Find the value of the Spearman's rank correlation coefficient  $r_s$ . [2]

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(e.ii) Interpret the value obtained for  $r_s$ . [1]

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(f) When calculating the ranks, Chester incorrectly read the Netherlands' score as 478. Explain why the value of the Spearman's rank correlation  $r_s$  does not change despite this error. [1]

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