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LEVEL 3 CERTIFICATE

Examiners' report

CORE MATHS B (MEI)

H869

For first teaching in 2016

H869/02 Summer 2024 series

Version 1

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Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 2 series overview

Candidates demonstrated a good understanding of the specification in their attempts at this paper. Mathematical calculations were mostly presented clearly, and a wide range of diagrams and situations were interpreted correctly. Some candidates did not have a secure understanding of hypothesis testing and, for example, began with a wrong alternative hypothesis or did not appreciate how to calculate the degrees of freedom for a contingency table. The best candidates showed fluency in procedural skills and strategies and were also able to critique and interpret successfully a broad range of scenarios and statements.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• structured their calculations clearly • applied statistical thinking and modelling skills in a variety of real-life situations • worked accurately and considered whether their answers were sensible in context • gave clear explanations supported by evidence when asked to critique or justify statements and hypotheses • worked confidently in response to questions based on the pre-release information.	• did not present their calculations clearly and made frequent errors in their workings • only worked confidently in familiar situations • did not use all relevant information when asked to critique or justify statements and hypotheses • seemed unfamiliar with skills and contexts arising from the pre-release information.

Section A overview

Candidates generally made a strong start to this section, presenting good arguments to each scenario. Some candidates were not able to critique the use of a normal distribution in context, but most were able to carry out area and probability calculations effectively. Many candidates were confident in carrying out the chi-squared test for independence.

Question 1 (a)

1 A town's council announce that they are planning to install speed bumps on Oak Road which runs in front of Oak School.

Not everyone supports this proposal and the council receive several letters of objection.

(a) Give **one** reason in favour of the speed bumps. **[1]**

This question was done well, with most candidates saying that reducing speeding would improve safety for the school children.

Question 1 (b) (i)

Before going ahead with the speed bumps, the council post the questionnaire in **Fig. 1.1** on their website and invite the town's residents to respond.

Fig. 1.1

1	How often do you drive along Oak Road?		
	(A) Every school day	(B) Several times a month	(C) Seldom or never
2	How many children do you have at Oak School?		
	(A) None	(B) 1	(C) 2 or more
3	Do you support the plan for speed bumps on Oak Road?		
	(A) Yes	(B) No view	(C) No
4	What is your age?		
	(A) under 21	(B) 21–45	(C) Over 45

Fig. 1.2 shows the answers from the first 8 responses the council receive. The responses are labelled L to S.

Fig. 1.2

	Response							
Question	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**
1	A	A	B	A	A	A	B	C
2	A	C	A	A	C	C	A	B
3	C	A	C	C	A	A	C	A
4	C	B	C	A	B	C	A	B

A member of the council looks at these 8 early responses and reports to the others on the outcomes so far.

(b) (i) How would you best describe the sample?
Circle **one** of the options in the answer space. **[1]**

1(b)(i)	**Opportunity**	**Self-selected**	**Cluster**
	Simple random	**Quota**	**Stratified**

Responses were mostly correct, with candidates choosing self-selected. A common incorrect answer was opportunity sampling.

Question 1 (b) (ii)

(ii) What do the responses to question 1 in **Fig. 1.2** suggest? **[1]**

Nearly all candidates correctly stated that most respondents use Oak Road frequently.

Question 1 (b) (iii)

(iii) Look at the responses to questions 2 and 3 in **Fig. 1.2** together. What do they suggest? **[2]**

Many candidates correctly described the strong link between opinions on speed bumps and whether respondents had children at the school.

Question 1 (c) (i)

When all the responses have come in, the council publish the results as **Fig. 1.3**.

Fig. 1.3

	Responses		
Question	**A**	**B**	**C**
1	95	34	4
2	52	26	55
3	70	3	60
4	9	72	31

(c) (i) Which question did some respondents definitely **not** answer? How do you know this? Circle **one** of the options in the answer space. **[2]**

Question 4 was identified correctly by nearly all candidates, and their choice was justified by checking how many responses there were to each of the four questions.

Question 1 (c) (ii)

(ii) Suggest a reason for some people **not** answering that particular question. **[1]**

Responses were nearly always correct with candidates pointing out either that respondents might be reluctant to give personal information, or that they might not have answered this survey question because it seemed irrelevant.

Question 1 (c) (iii)

(iii) Given your answer to part **(b)(iii)**, explain briefly why **Fig. 1.3** is **not** an informative way to show the results. **[1]**

Candidates struggled with this question. The best responses built on earlier question parts, particularly Question 1 (b) (iii), to state that Fig 1.3 fails to show the links between respondents' answers to the survey.

Question 2 (a)

2 Parkruns are held every Saturday morning in many places around the country. Each Parkrun is 5 km long and is free to enter.

A group of 8 people want to set up a Parkrun in their town. They have a suitable course but need to get agreement from the national organisers.

To help with this, the group run the course. Their times are recorded and given in cells B1 to B8 of the spreadsheet shown below.

	A	B
1	1st	17.25
2	2nd	18.75
3	3rd	20.00
4	4th=	22.15
5	4th=	22.15
6	6th	27.22
7	7th	30.55
8	8th	33.95
9		
10	Mean	24.00
11	SD	5.96

The times are given in minutes, as decimals, to the nearest 0.01 minutes. They are **not** given in minutes and seconds.

Thus in the entry 17.25, the .25 means $\frac{25}{100}$ of a minute or $\frac{25}{100} \times 60 = 15$ seconds.

So the time of 17.25 means 17 minutes 15 seconds.

The figures in cells B10 and B11 are the mean and standard deviation of the figures in cells B1 to B8.

(a) Write the time given in cell B8 in minutes and seconds. **[1]**

Most candidates correctly converted 0.95 minutes to 57 seconds and gave the fully correct answer 33 minutes 57 seconds, but a few forgot to write the 33 minutes.

Question 2 (b)

(b) Complete the blank spaces in the formula =STDEV(.... : ....) used to find the number in cell B11. **[1]**

Assessment for learning

Many candidates did not know how to identify the cells required, (B1: B8), for the spreadsheet calculation. Creating and analysing spreadsheets by using formulas should be a focus for learning in this qualification.

OCR support

Practical spreadsheet activities to develop understanding of simple formulae can be downloaded from Teach Cambridge:

Notes on the pre-release data set

Question 2 (c)

(c) The leader of the group says "Our data show that when our Parkrun happens and a lot of people do it, their times will be Normally distributed with mean 24 minutes and standard deviation 6 minutes."

Give **two** criticisms of the leader's statement. **[2]**

There were a wide range of responses to this question. The best responses referred clearly to the leader's statement and made comments about whether such a small group would give results that were representative of a much larger group of runners, or questioned whether there was really any evidence of a Normal distribution as claimed from the eight results.

Question 2 (d) (i) and (ii)

The Parkrun is given permission to go ahead. On the first day 400 people participate.

The times of the 400 people are recorded carefully and it is found that they can be modelled by a Normal distribution with mean 30 minutes and standard deviation 6 minutes.

(d) How many of the 400 participants would be expected to take:

(i) less than 18 minutes

(ii) 36 minutes or more? **[4]**

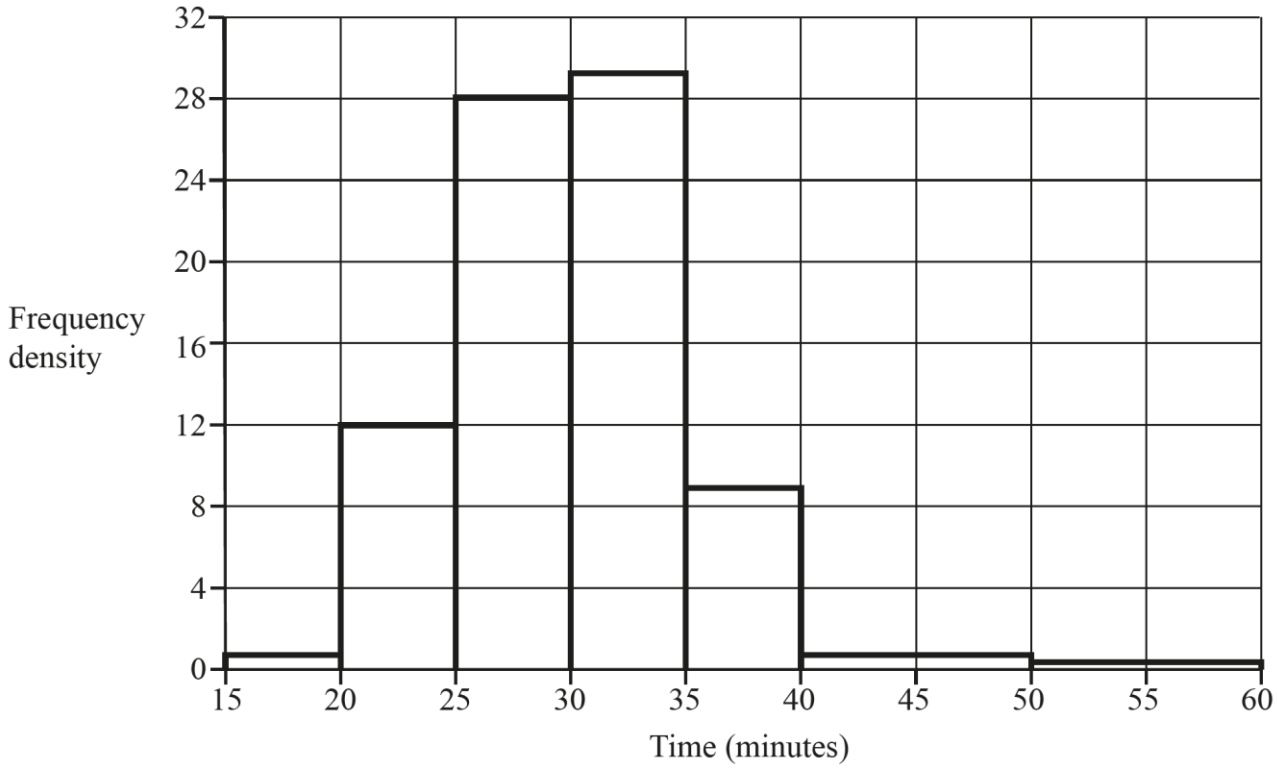
Modelling with the Normal distribution

There were a number of fully correct responses. Many good responses used area approximations for a normal distribution as given in the specification for this qualification. Other good responses used correct probabilities from the Normal distribution tables or by using the relevant statistical distributions menu from a calculator. Occasionally probabilities or areas were given as the final answer, rather than using these to calculate the numbers expected from a sample of 400 runners.

Candidates should be given opportunities to model probabilities/outcomes with the Normal distribution in various real-life contexts using both methods when studying this qualification. Whichever method is used, understanding should be reinforced by encouraging candidates to use simple sketches of the distribution which emphasise the symmetrical nature of this statistical model either side of the mean.

Question 2 (e)

On another Saturday, 400 people take part in the Parkrun. The distribution of their times is shown in this histogram.



(e) Write down **one** feature of the histogram that shows the distribution of these runners' times is **not** Normal.

Give an explanation of why this might be the case for participants in the Parkrun. **[2]**

Most candidates correctly pointed out that the results were not symmetrical, either directly, or by referring to the positive skew. The best explanations of this feature referred clearly to characteristics of participants in the Parkrun, for example referring to the wide range of fitness levels which could easily lead to some people taking much longer than others to complete the event.

Exemplar 1

2(e)	**Feature of the histogram**
	it's not symmetrical
	Explanation
	it's free to enter, they're not going to all be professional runners, some people may walk and take longer than mean time

In Exemplar 1, the candidate identifies the relevant feature and describes clearly why this might have occurred in the context of a Parkrun.

Question 3 (a)

3 The present standard treatment for a particular disease is not always effective. A pharmaceutical company is developing a new medicine. Their tests show that it is more effective in treating the disease and they are now investigating possible side effects.

One side effect of the standard treatment is sleep loss in many patients. The company investigate whether this is also the case for their new treatment.

A number of patients with the disease volunteer to take part in a test relating to sleep loss. Those selected are allocated to three groups:

- receiving no treatment
- taking the standard treatment
- trialling the new medicine.

They are asked whether they have suffered no sleep loss, mild sleep loss or severe sleep loss since having the disease. The results are shown in **Fig. 3.1**.

Fig. 3.1

Observed frequency, f_o	**Sleep loss**			
Treatment	**No**	**Mild**	**Severe**	**Total**
No	9	16	5	**30**
Standard	5	11	24	**40**
New	28	15	7	**50**
Total	**42**	**42**	**36**	**120**

A chi-squared test is carried out using these data, using a 5% significance level.

(a) Which of the following is a suitable Null Hypothesis for the test?
Circle **one** of the options in the answer space. **[1]**

A The proportions of people with No, Mild or Severe sleep loss are independent of the treatment.

B The new treatment causes less sleep loss than the standard.

C Side effects should be avoided.

D The proportions of people with sleep loss depend on the treatment.

The correct option (A) was nearly always chosen for this chi-squared hypothesis test for independence.

Question 3 (b)

(b) Complete **Fig. 3.2** in the Answer space giving the Expected frequencies. **[2]**

3(b) **Fig. 3.2**

Expected frequency, f_e	Sleep loss			
Treatment	**No**	**Mild**	**Severe**	**Total**
No	10.5	10.5	9.0	**30**
Standard				
New	17.5	17.5	15.0	**50**
Total	**42**	**42**	**36**	

This was nearly always correct. A few candidates calculated the expected frequencies by using appropriate row and column totals from the observed frequency table Fig 3.1, but most realised that the missing expected frequencies could be calculated quite easily by using the other cells in Fig 3.2.

Question 3 (c)

(c) Complete the calculation of X^2 in **Fig. 3.3** in the Answer space. **[2]**

3(c) **Fig. 3.3**

$$X^2 = 0.214... + 2.880... + 1.777...$$
$$+ 5.785... + 0.642... + 12.000...$$
$$+ 6.300... + ... + 4.266...$$
$$= ..... \text{ (to 1 d.p.)}$$

This missing contribution and total chi-squared value were nearly always calculated correctly.

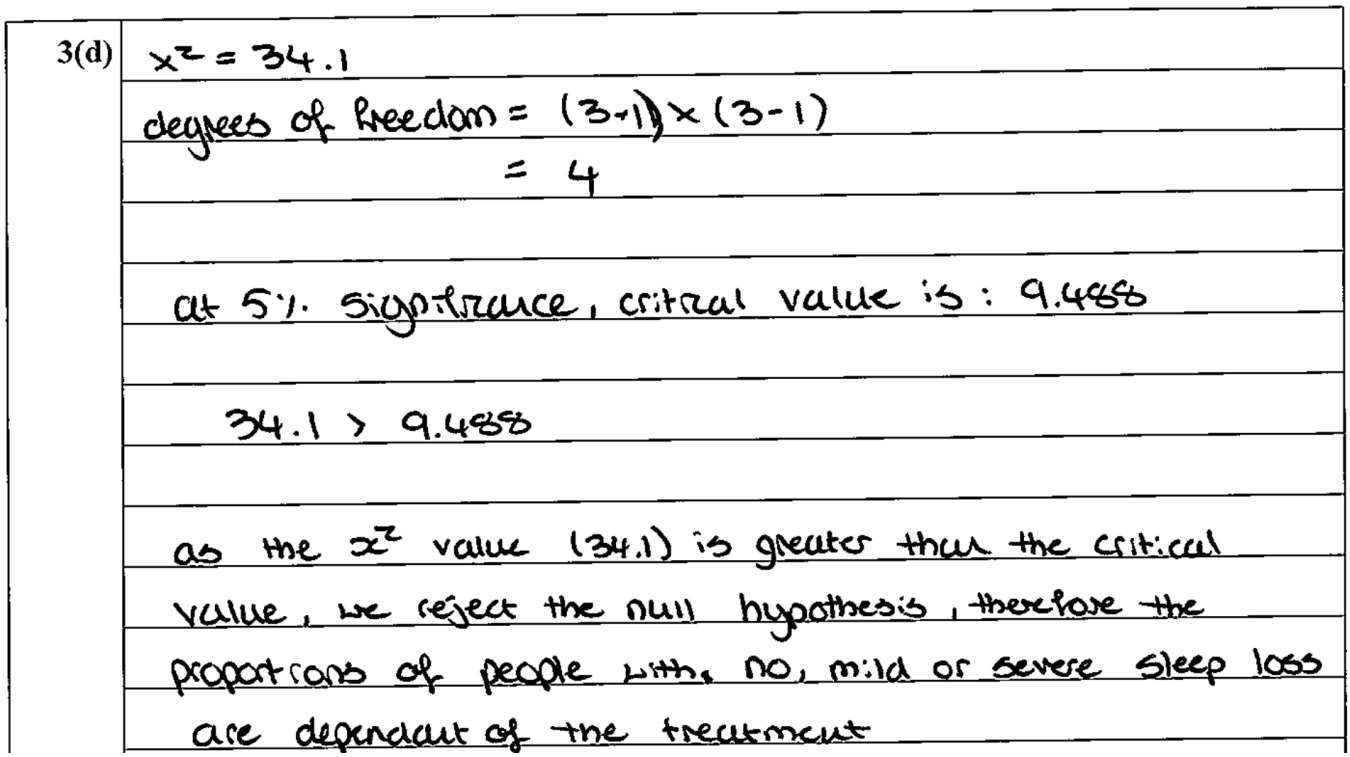
Question 3 (d)

(d) Complete the test and show that it is significant. **[4]**

Assessment for learning

It was clear that some candidates did not know how to calculate the degrees of freedom from a contingency table using the formula: $v = (\text{rows}-1)(\text{columns}-1)$. Those that did, often completed the test very efficiently.

Exemplar 2



In Exemplar 2, the candidate has carried out the test efficiently and clearly, showing all steps and with a clear and correct conclusion.

Question 3 (e)

(e) State whether there is enough evidence that the new treatment should be refused a licence for public use. Give your reason. **[2]**

The best responses started with a clear decision about whether there was enough evidence to refuse a licence or not and justified this decision with an appropriate reason. Most responses referred to relevant data about sleep loss in Fig 3.1.

Section B overview

Nearly all candidates were able to find and use relevant information from the spreadsheet insert in their calculations. A few were unclear about spreadsheet operations such as how to specify cell range in a formula, and instructions about rounding answers were often ignored. While there were many good explanations in context for each scenario, some responses lacked clarity and focus.

Question 4 (a)

4 **(a)** Using figures from the pre-release data, show that the population of Cuba is decreasing by over 30 000 people per year. **[2]**

Most candidates used the correct figures to show the change in population as 32 000 or better, but a few did not justify that this was a decrease.

Question 4 (b)

Simon and Tara need to estimate the annual change in the number of people in the world.

They must decide on the best procedure to use given the data available to them. They have a paper copy of the pre-release data (the same as the one given out with this paper), but do not have an electronic version.

They suggest different methods, as shown in the table below.

Simon's method	Tara's method
Find the total population for all countries and the average growth rate per country. Then multiply the total population by the average growth rate and divide by 100.	Add up the values of $\text{Population} \times \frac{\text{Growth rate}}{100}$ for all countries

They decide to try the two methods on the five countries of North America because they are a small sample and so do not involve a lot of work.

They enter these countries into the table in **Fig. 4.1** in the Answer space, together with the information that they will need.

(b) Complete the **three** empty cells in **Fig. 4.1**. **[2]**

4(b) **Fig. 4.1**

Country	**Population, p**	**Growth rate, r%**	**$\frac{p \times r}{100}$**
Bermuda	70 864	0.45	319
Canada	35 623 680		
Greenland	57 713	−0.03	−17
Saint Pierre and Miquelon	5 533	−1.08	−60
United States	326 625 791	0.81	2 645 669
Total	**362 383 581**	**0.88**	

Most candidates used the relevant growth rate for Canada to calculate $\frac{p \times r}{100}$ correctly. However, many did not realise that the total in the bottom right cell would come from adding the cells above.

Question 4 (c)

(c) Find the annual increase in the population given by each of the methods, giving your answers to the nearest thousand people. **[2]**

A common error in this question was not dividing the 0.88 by 5 in Simon's method to obtain the average growth rate for the five countries. The estimate using Tara's method was often correct or followed through correctly from the bottom right cell of Fig 4.1. Many candidates lost marks as they did not round to the nearest thousand as requested.

Question 4 (d)

(d) State, with a reason, which is better: Simon's method or Tara's method. **[1]**

There were many good responses that described clearly Tara's method was better because it used the actual population growth for each individual country and then totalled them.

Question 4 (e)

One of their colleagues then supplies them with an electronic version of the pre-release data. They use this to find the totals for all the countries for which the data are available. They are given below.

	Population, p	**Growth rate, r%**	$\frac{p \times r}{100}$
Total for all countries	7 405 119 557	256.16	76 946 645

(e) Find the best estimate of the annual growth in the world's population to the nearest million people. **[1]**

Few candidates chose the final cell in the table provided and rounded it as required. This was perhaps because they had not realised earlier that Tara's method gave the best estimate.

Question 5 (a)

5 (a) Write down the population and the total area of Namibia. **[1]**

Nearly always correct.

Question 5 (b)

(b) Using the pre-release data, calculate the value of C40/D40. Give your answer to **2** decimal places.

State what this value represents. **[2]**

The calculation was nearly always correct, but occasionally the value was not rounded as requested to two decimal places. Most candidates realised that this was the population density or stated clearly that this was the number of people per square kilometre.

Question 5 (c)

(c) The value of SUM(C2:C57) is 1 222 204 378.

State what this value represents. **[1]**

Nearly always correct, but some candidates misinterpreted the spreadsheet notation and stated that it was the population of Algeria and Zimbabwe.

Question 5 (d)

(d) The value of SUM(D2:D57) is 30 312 642.

Calculate the value of SUM(C2:C57)/SUM(D2:D57).

State what this value represents. **[2]**

Most did the calculation correctly and realised that this was the population density of Africa.

Question 5 (e)

(e) A lot of Namibia is in the Namib desert.

Explain briefly how this influences the answers to parts **(b)** and **(d)**. **[1]**

Most candidates gave a clear description of the implication of large areas of uninhabitable desert on population density.

Question 5 (f)

A student wants to investigate further.

She starts new columns, P and Q, on the spreadsheet of the pre-release data.

She enters

= C2/D2

into P2 and then copies it down to P237.

She then uses the spreadsheet's RANK command to obtain the ranks of the numbers in column P. She places them in column Q. The highest value of P is ranked 1.

(f) Row 180 had to be excluded.

Explain why. **[1]**

Many responses were too vague and did not point towards the fact that it is not possible to obtain an answer when you try to divide by zero.

Question 5 (g)

(g) Namibia is ranked 229.

How many countries have a lower value in column P than Namibia? **[1]**

Very few candidates did the calculation necessary to determine the number of countries. Others forgot to reduce their answer by one to take account of the exclusion of row 180 (Holy See).

Question 6 (a)

6 **(a)** Show that, to the nearest whole number, the electricity consumption per person in Algeria is 1304 kWH per year. **[2]**

Most responses used the correct spreadsheet values in a calculation with sufficient detail to show the given result. A common error was not multiplying by a million.

Question 6 (b)

This letter is published in a newspaper in the UK.

> It is time we took our responsibility for the planet seriously.
>
> Throughout the world, the people who live in richer countries use more electricity and so cause more harmful emissions.
>
> The answer is simple. Tax rich people more.

Mary reads this and decides to check whether it is the case that countries with high GDP per capita also have high electricity consumption per capita. She works with a sample of 8 countries.

Mary selects 8 countries at random. They are given in **Fig. 6.1** in the Answer space, together with some relevant figures.

Mary completes **Fig. 6.1** and uses Spearman's Rank Correlation Coefficient to carry out a suitable hypothesis test at the 5% significance level.

(b) The Null Hypothesis for the test is
"H_0: There is no association between electricity consumption per capita and GDP per capita."

Write down the Alternative Hypothesis. **[1]**

Misconception

Many candidates did not appreciate that the alternative hypothesis is determined by exactly what is being tested in any given situation. In this question Mary was checking whether the newspaper report was correct in describing a positive association between GDP and electricity consumption, rather than testing for association. Positive association then leads to a one-tailed (rather than two-tailed) test being carried out.

Question 6 (c)

(c) Complete **Fig. 6.1** and use it to calculate the value of r_s.

Carry out the test and show the result is significant. **[5]**

6(c) **Fig. 6.1**

Country	Electricity consumption per capita (kWH pa)	Electricity rank, x	GDP per capita PPP ($)	GDP rank, y	$d = x - y$	d^2
Malawi	103	8	1 200	8	0	0
Canada	14 502	1	48 100	2	−1	1
Chile	3 820	3	24 600	4	−1	1
India	818	7	7 200	7	0	0
Dominica	1 183	5	12 000	5	0	0
Poland	3 672	4	29 300	3		
Sweden	12 590	2	51 300	1		
Fiji	899	6	9 900	6		
				Total		

The missing values in the table were nearly always completed correctly. Most candidates calculated Spearman's rank correlation coefficient correctly using the formula given in the formula booklet. Those candidates who had realised that this was a one-tailed test went on to compare their correlation coefficient with the correct critical value from the relevant table in the formula booklet and draw an appropriate conclusion.

Question 6 (d) (i)

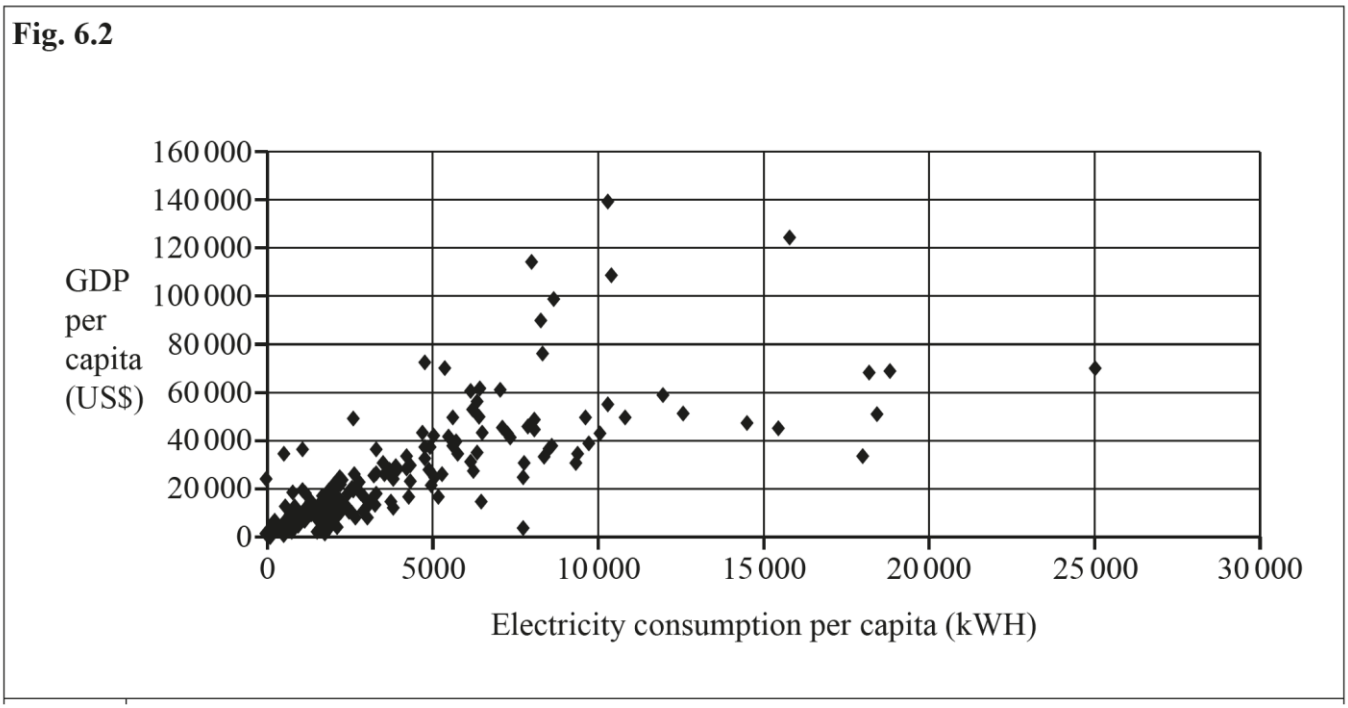
Mary is encouraged by the significant result but thinks it should be treated with caution because the sample was so small.

Mary uses all the available data from the pre-release to draw a scatter graph of electricity consumption per capita and GDP per capita.

Fig. 6.2 shows the scatter graph after Mary has removed Iceland from the data set, which was an outlier.

(d) (i) Draw the line with equation $y = 6x$ on **Fig. 6.2** in the Answer space. **[1]**

Fig. 6.2



The line was often not drawn in the correct position, with some candidates perhaps not realising how the given equation related to the axes/variables.

Question 6 (d) (ii)

(ii) State, with a reason, whether the line $y = 6x$ is a suitable Line of Best Fit for the scatter graph. **[1]**

The best responses stated quite simply that the line was suitable because it was a good fit to the data on the scatter graph.

Question 6 (d) (iii)

(iii) Iceland has:

- electricity consumption per capita = 52 922 kWH
- GDP per capita = 52 100 US$

Would Iceland lie above, on or below the line $y = 6x$? **[1]**

While there were many correct responses (below the line), these were often based on intuition rather than being justified by a calculation.

Question 6 (e)

(e) The letter to a newspaper earlier in the question included these two statements.

Statement 1

"*Throughout the world, the people who live in richer countries use more electricity.*"

Statement 2

"*The answer is simple. Tax rich people more.*"

State, giving brief explanations, whether these statements are justified.

Your explanations may be based on your general knowledge or on information from this question. **[2]**

Many appropriate criticisms were seen for each of the two statements. The best responses stated clearly whether or not each statement was justified and went on to explain with sufficient detail in the context of electricity consumption.

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