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Examiners' report

CORE MATHS B (MEI)

H869

For first teaching in 2016

H869/02 Summer 2023 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 presented clearly, and a wide range of diagrams and situations were interpreted correctly. Calculations for hypothesis tests were usually accurate, but explanations of test results and conclusions were often less successful. The best responses showed fluency in procedural skills, statistical problem-solving and strategies, applied to both familiar and unfamiliar real-life contexts. Examiners saw many excellent descriptions and interpretations.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• applied statistical thinking and modelling skills in a variety of real-life situations • structured their calculations clearly • worked accurately and considered whether their responses were sensible in context • used sketches to support calculations where appropriate • 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.	• only worked confidently in familiar situations • did not present their calculations clearly and made frequent errors in their workings • did not support calculations with appropriate sketches • did not use all the relevant information when asked to critique or justify statements and hypotheses • seemed unfamiliar with skills and contexts associated with the pre-release information.

Section A overview

Candidates generally made a strong start to this section, presenting appropriate calculations for the situations described. However, candidate responses often lacked clarity where explanations and justifications were required. Most candidates were familiar with the process for standardising a Normal distribution, but many were unable to use area approximations effectively. Many candidates struggled with the metric and imperial height conversions in Question 3.

Question 1

1 The article below was written by a journalist and appeared in the local newspaper of a small town. The town is on a main railway line and has a station.

More parking needed

If you want to travel by train you'll most likely have to think again. There are just 35 parking spaces at our station and on most days you won't be able to find an empty one to park your car in.

Many readers have told me that parking is a problem. So I decided to see for myself and went to the station at 9 am on each of the ten working days in a fortnight. Every day I checked whether each of the 35 parking spaces was occupied or free. So overall I carried out 350 checks. Here are the numbers of parking spaces I found free on the different days.

Free parking spaces

	Mo	Tu	We	Th	Fr
Week 1	0	2	0	0	5
Week 2	1	0	0	0	6

So the readers are right. My checks showed that, at the times I was there, over 95% of the parking spaces were occupied. Most days there was nowhere to park at all. While I was at the station several cars drove round the car park looking for a space that wasn't there and so they continued their journey by road.

It is time for those responsible to wake up. The car park needs to be enlarged.

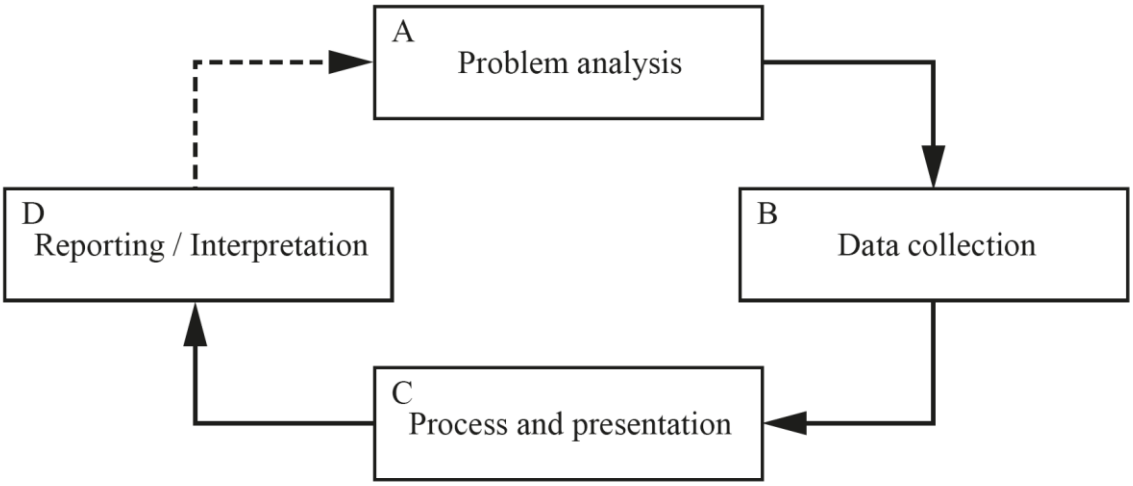
(a) Show that overall for over 95% of the checks that the journalist made the parking spaces were occupied. **[2]**

This question was well answered, with candidates either showing that 14 unoccupied spaces represented 4% of the total or that 96% of spaces were filled.

Question 1(b)

The diagram below shows the four stages of the Statistical Problem Solving Cycle.

The piece of work described in the journalist's article fits this cycle.



(b) The following sentences are taken from the journalist's article. In each case say which of the stages, A, B, C or D, the work described fits into. **[4]**

1(b)(i)	over 95% of the parking spaces were occupied. **Stage**
(ii)	The car park needs to be enlarged. **Stage**
(iii)	Every day I checked whether each of the 35 parking spaces was occupied or free. **Stage**
(iv)	Many readers have told me that parking is a problem. **Stage**

Nearly all candidates correctly identified the four stages of the cycle in relation to the article.

Question 1 (c)

(c) A member of the railway company's staff said "The article is not fair because the times sampled were not random". Comment critically on this statement. **[1]**

Most candidates made a good attempt at critiquing the statement by referring to the demand for parking by rail users across the week. Clear arguments were accepted both for and against the statement.

Question 2 (a)

2 Jamila is a sociology student. She is carrying out a project on the reactions of men, women and young people to global warming.

She draws up the short questionnaire in **Fig. 2.1**.

Fig. 2.1

1. Please choose the **one** of the following actions you are most likely to take to reduce global warming. Circle A, B, C or D.

A I should stop eating meat

B I should spend at least one day a month planting trees

C For long journeys I should travel by train or bus and for short ones I should walk or cycle

D The climate will look after itself and so I don't need to do anything special

2. Describe yourself by ringing one of the following.

A young person (under 18) An adult woman An adult man

Thank you.

Jamila asks her classmates and friends to complete the questionnaire. She also asks them to get their parents and their friends to do it.

The results are summarised in **Fig. 2.2**.

Fig. 2.2

Observed frequency, f_o	**Young people**	**Adult women**	**Adult men**	**Total**
Statement A	25	12	12	**49**
Statement B	10	13	12	**35**
Statement C	13	23	23	**59**
Statement D	0	4	13	**17**
Total	**48**	**52**	**60**	**160**

Jamila uses the data to carry out a χ^2 hypothesis test at the 1% significance level.

(a) Which one of these is the null hypothesis for Jamila's test? **[1]**
Circle **one** of the options in the answer space.

P Young people are better informed about global warming than adults.

Q The proportions of people holding particular opinions about global warming are independent of whether they are young or adult (men or women).

R Men and women hold the same views about global warming.

S All of the courses of action stated are equally important.

2(a)	P	Q	R	S

Nearly all candidates correctly identified Q as the null hypothesis.

Question 2 (b)

(b) Complete the table of Expected frequencies given as **Fig. 2.3** in the answer space. **[2]**

2(b) **Fig. 2.3**

Expected frequency, f_e	Young people	Adult women	Adult men	Total
Statement A	14.7	15.925	18.375	**49**
Statement B	10.5	11.375	13.125	**35**
Statement C	17.7	19.175	22.125	**59**
Statement D				
Total				

This question was very often correctly answered, with expected frequencies calculated as required, assuming that the statements were independent of the age groups in line with the null hypothesis.

Question 2 (c)

(c) Complete the calculation of X^2 in **Fig. 2.4** in the answer space. **[2]**

2(c) **Fig. 2.4**

X^2 = ... + 0.967 ... + 2.211 ...

\+ 0.023 ... + 0.232 ... + 0.096 ...

\+ 1.248 ... + 0.763 ... + 0.034 ...

\+ 5.100 ... + 0.420 ... + 6.884 ...

X^2 = ... (to 1 d.p.)

Answers to this question were nearly always correct, showing a good understanding of how the chi-squared contributions are calculated and summed to give an overall value.

Question 2 (d)

(d) Show that the test is significant at the 1% level. **[4]**

A very common error was not knowing how to calculate the degrees of freedom (DOF) for this test, using the number of rows and columns in the contingency table. Despite incorrect DOF, most candidates looked up an appropriate 1% critical value in the statistical tables to compare with their response to Question 2 (c).

Question 2 (e)

(e) Jamila is very excited by the result. She says

"The overall result and the contributions to X^2 prove that young people everywhere have the best ideas and adult men's views can't be trusted".

Give **two** different criticisms of Jamila's statement. **[2]**

2(e)	**Criticism 1**
	Criticism 2

Most candidates commented on Jamila's sample being too small or only drawn from her friendship group, and it would therefore be unreliable to claim conclusions about people 'everywhere'. More successful candidates made a clear second criticism that the chi-squared test does not validate the views of any particular group on climate change, it only tests whether views are independent of the groups.

Question 3 (a) (i)

3 **Fig. 3** shows a Normal distribution with mean 176 and standard deviation 7.

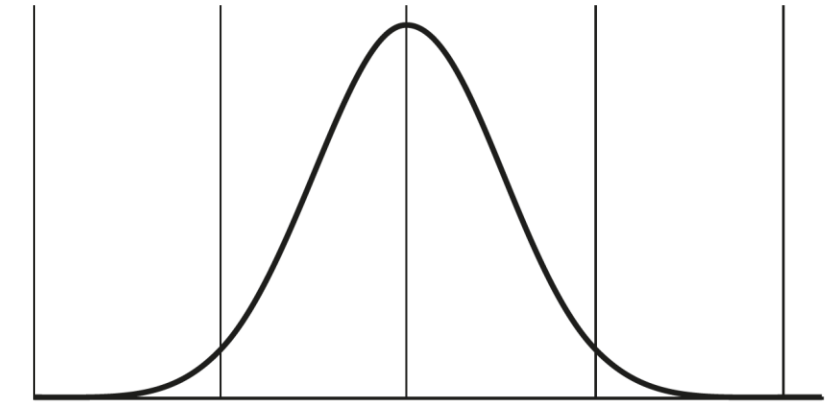
(a) (i) Show that the z-values of 204 and 148 are +4 and −4. **[2]**

A variety of methods were seen in this question, which showed good understanding of how to standardise a Normal distribution.

Question 3 (a) (ii)

(ii) Mark the horizontal scale in integer values of z from −4 to +4. **[1]**

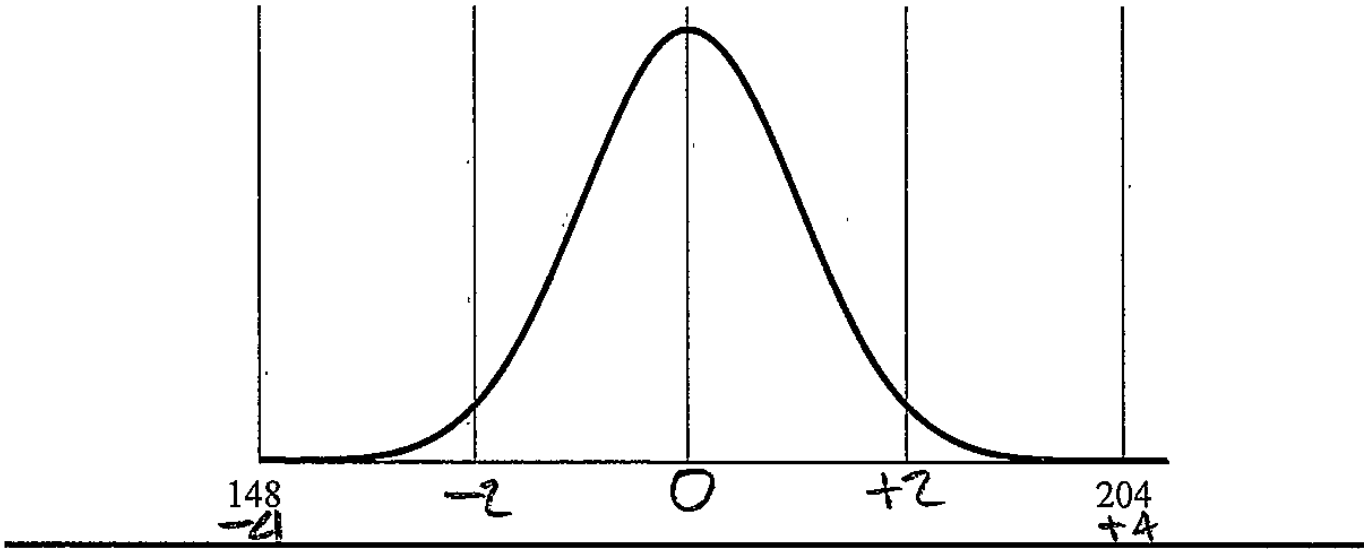
(ii) **Fig. 3**



This question was only answered well by a very small proportion of candidates. Some were perhaps confused by the existing labels on the diagram which may have also made it difficult to mark z-values at $z = \pm 4$.

Exemplar 1

Fig. 3



This exemplar correctly shows the *z*-values on the horizontal axis for the Normal distribution in the question. The values of 148 and 204 represent 4 standard deviations either side of the mean, 176, which were given in Question 3 (a)(i). Sight of these values on the horizontal axis may have confused some candidates. This candidate was credited 1 mark for marking zero and even integer *z*-values on the scale.

Question 3 (b)

(b) Find the area of the region between $z = -1$ and $z = +2$. **[3]**

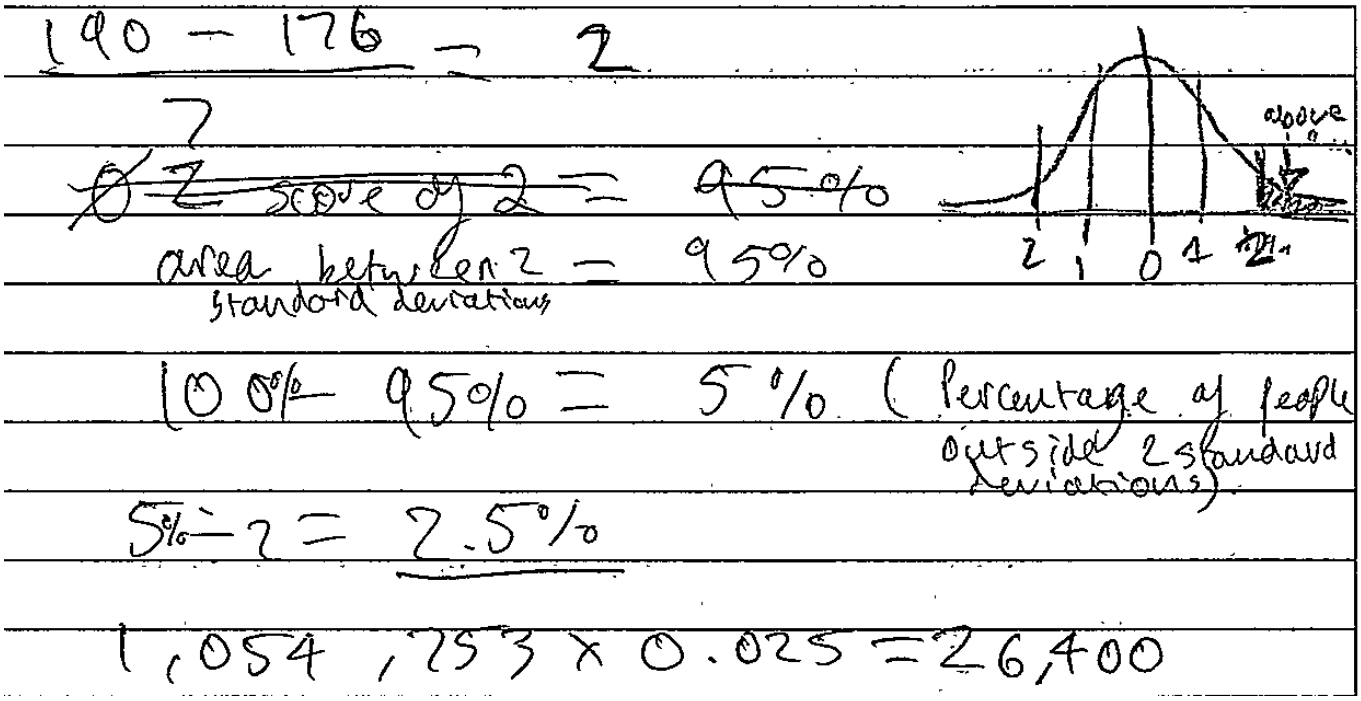
The responses to this question were very mixed. Many candidates quoted 68% or 95% as the approximate proportion of values lying within 1 or 2 standard deviations of the mean respectively but were unable to make progress in calculating the required asymmetrical area. Candidates should be encouraged to use simple sketches to represent *z*-values and areas when working with the Normal distribution. Very occasionally candidates used values taken from the standard Normal tables and these attempts were usually successful.

Question 3 (c)

The graph in **Fig. 3** shows the distribution of the heights in centimetres of adult men in the USA.

(c) A recent survey in Chicago showed that 1 054 753 adult men lived there.
Estimate, to the nearest 100, how many of them were at least 1.9 metres tall. **[3]**

This question was not answered well, with very few candidates making the link that a height of 1.9 metres represented approximately 2 standard deviations above the mean.



Exemplar 2

This exemplar includes a working sketch that correctly identifies the relevant part of the distribution. The shaded area in the sketch shows adult men who are 'above' 2 standard deviations from the mean.

The candidate has started by calculating the relevant *z*-value, 2.

The candidate is using area approximations and has identified the relevant area as half of that remaining when the area between 2 standard deviations, 95%, is subtracted from 100% and halved leading to 2.5% of the total. An estimate for the number of men is then obtained by calculating 2.5% of the total and rounding to 3sf as requested. This response was given full marks.

Question 3 (d)

(d) The mean height of adult males in Peru is 5 feet $4\frac{1}{2}$ inches.

In which country, the USA or Peru, is the mean height of adult men greater, and by how much?

[1 metre is 3 feet 3.4 inches and 1 foot is 12 inches.] **[3]**

This part was too challenging for many candidates, who struggled to apply appropriate conversions between the metric and imperial systems of measurement. The best solutions used the given conversion to obtain a multiplication factor of 3.283 to efficiently convert 1.76 m into feet, and then multiplied by 12 to get the height in inches, 69.344. Some who obtained a correctly converted measurement forgot to determine the difference in the mean height between the two countries.

Misconception

A common misconception was to write the given '3 feet 3.4 inches' as a multiplication factor of 3.34, which could not earn any marks. The correct conversion factor of 3.283 is obtained by adding 3 and 3.4 divided by 12:

$$3 + \frac{3.4}{12} = 3.283$$

Section B overview

Most candidates made a strong start to this section and were clearly familiar with the calculations required for rank correlation. However, many did not appreciate that the hypothesis described required a one-tail test to be carried out. Nearly all candidates used the insert to find relevant information, but many were unclear about spreadsheet operations despite this material being part of the pre-release for this examination series. Candidates need to make sure that they use values given in questions in their responses, and should not take their own readings where exact values are provided.

Question 4 (a)

4 Riley says "I expect that the larger a country, the greater will be the length of its roads".

Taylor disagrees. "Many large countries have open spaces where nothing much happens".

They decide to carry out a test on a sample of countries. They choose one country at random from each region in the pre-release data set. (See **Fig. 4**.)

Then they calculate Spearman's rank correlation coefficient and use it to carry out a hypothesis test at the 5% significance level on Riley's theory.

(a) Complete the table in the answer space and calculate r_s. **[4]**

4(a) **Fig. 4**

Country	Area (km^2)	Area rank, x	Roads (km)	Roads rank, y	$d = x - y$	d^2
Tunisia	163 610	5	19 418	6	−1	1
Botswana	581 730		17 916			
Panama	75 420	6	15 137	8	−2	4
Canada	9 984 670		1 042 300			
Paraguay	406 752	3	32 059	4	−1	1
Laos	236 800	4	39 586	3	1	1
Jamaica	10 991	8	22 121	5	3	9
Denmark	43 094	7	74 497	2	5	25
Samoa	2 831	9	2 337	9	0	0
				Σ	0	

r_s = ...

Most candidates completed the table accurately and went on to use the correct formula to determine the correlation coefficient. A few made minor slips when using the formula, including forgetting to subtract from one.

Question 4 (b)

(b) Write down the null and alternative hypotheses for the test. **[1]**

4(b)	**Null hypothesis, H_0:**
	Alternative hypothesis, H_1:

Nearly all candidates understood that the null hypothesis for this type of test is always that there is no association/correlation. However, most did not recognise that Riley's statement was an example of positive association or positive correlation for the alternative hypothesis.

Question 4 (c)

(c) Complete the test and say whether the outcome supports Riley's theory. **[3]**

Errors in stating the alternative hypothesis inevitably led to candidates carrying out a two-tailed rather than one-tailed test. In most cases, this could only be given the method mark for comparing their rank correlation coefficient with a wrong critical value.

Question 4 (d)

(d) Give one reason why the result should be treated with caution. **[1]**

Most candidates gave a good reason in context, often referring to the fact that the sample of countries was relatively small or unrepresentative.

Question 4 (e)

The pre-release data cover 219 countries for which the values of land area and total road length are given. Riley uses the spreadsheet to find the product moment correlation coefficient for these countries. It is 0.6332.

(e) What should Riley and Taylor conclude from this figure? **[1]**

This question now included all countries in the pre-release insert. While most candidates recognised that 0.6332 is a relatively high value for a correlation coefficient, very few made the link specifically to Riley's statement about a positive association between country size and length of roads.

Question 5 (a)

5 **(a)** Write down the population and the birth rate of Ethiopia.

How many babies are born in Ethiopia in a typical year? **[2]**

5(a)	**Ethiopia Population**	**Birth rate**
	Babies in a typical year	

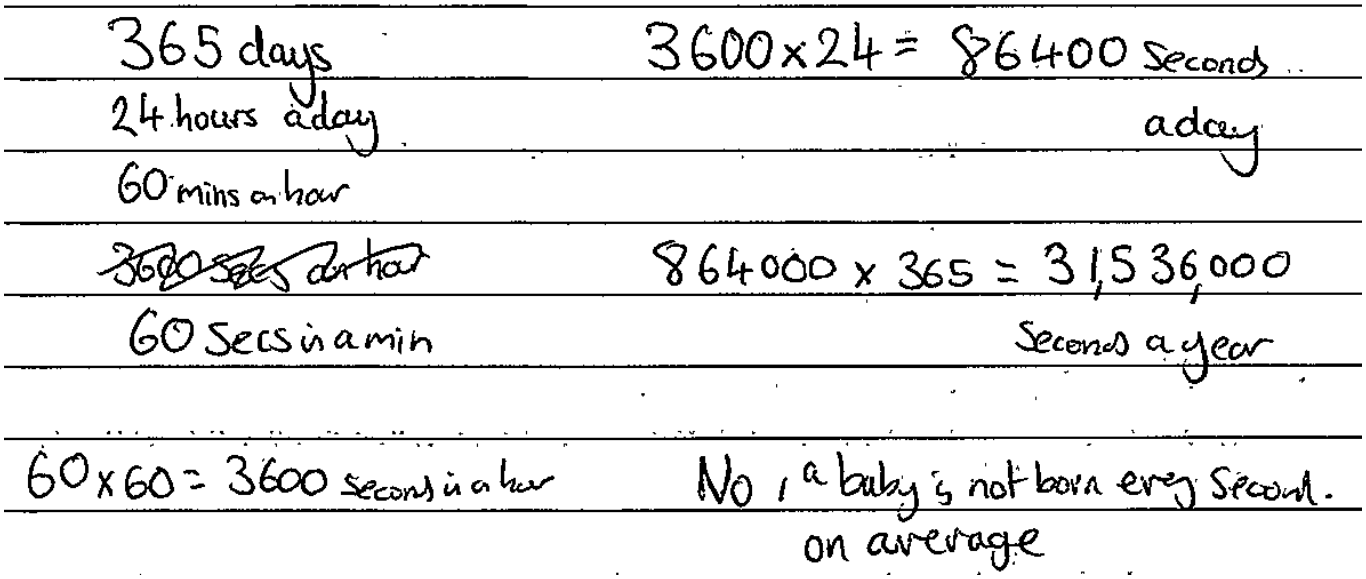
This question was nearly always correct, with values from the insert used to calculate the babies born in a typical year.

Question 5 (b)

(b) On average, is a baby born every second in Ethiopia? **[2]**

Nearly all candidates had a correct process for working out the number of seconds in a year. However, many were unsure how to use this to calculate the number of babies born per second or alternatively how often a baby is born.

Exemplar 3



This exemplar includes clear working to obtain the correct number of seconds in a year, 31 536 000. However, no justification is offered against the statement being tested so only 1 mark can be given.

The minimum required would have been comparing the number of seconds to the number of babies born in a year, 3 845 276, and stating that they are not the same. Better solutions showed the statement was incorrect by calculating the rate of babies being born, 0.12 per second, or how often a baby was born, around every 8 seconds.

Question 5 (c)

Jack calculates the birth rate across the world. He works with the spreadsheet containing the pre-release data.

He starts by deleting the ten countries for which data on population and birth rate are not both available.

Then he enters =(C2/1000)*J2 into cell P2 and copies P2 down to P237.

He enters =SUM(C2:C237) into C238 and gets 7 403 176 022.

He enters =SUM(P2:P237) into P238 and gets 135 877 586.

Finally he enters =P238/(C238/1000) into P239 and gets 18.35 (to 2 decimal places).

(c) Name one of the countries that Jack deletes. **[1]**

Nearly all candidates chose a correct country from the insert.

Question 5 (d)

(d) State what the numbers in C238, P238 and P239 represent. **[3]**

5(d)	**C238**
	P238
	P239

Many candidates struggled with this question. The data had been provided to centres as part of the pre-release for this examination series but many candidates seemed unfamiliar with the spreadsheet.

Working with the pre-release materials

It is essential that teaching and learning for this qualification includes some in-depth work on the information provided in the pre-release materials. Candidates will improve their understanding of the data set if they are able to work with the data in a spreadsheet. At the same time, knowledge of spreadsheet formulae and notations, which is assessed specification content, can be developed.

OCR support

Notes on the pre-release data set to help candidates work with the data set can be downloaded from Teach Cambridge:

Notes on the pre-release data set

Question 5 (e)

(e) On average, how many babies are born around the world every second? **[1]**

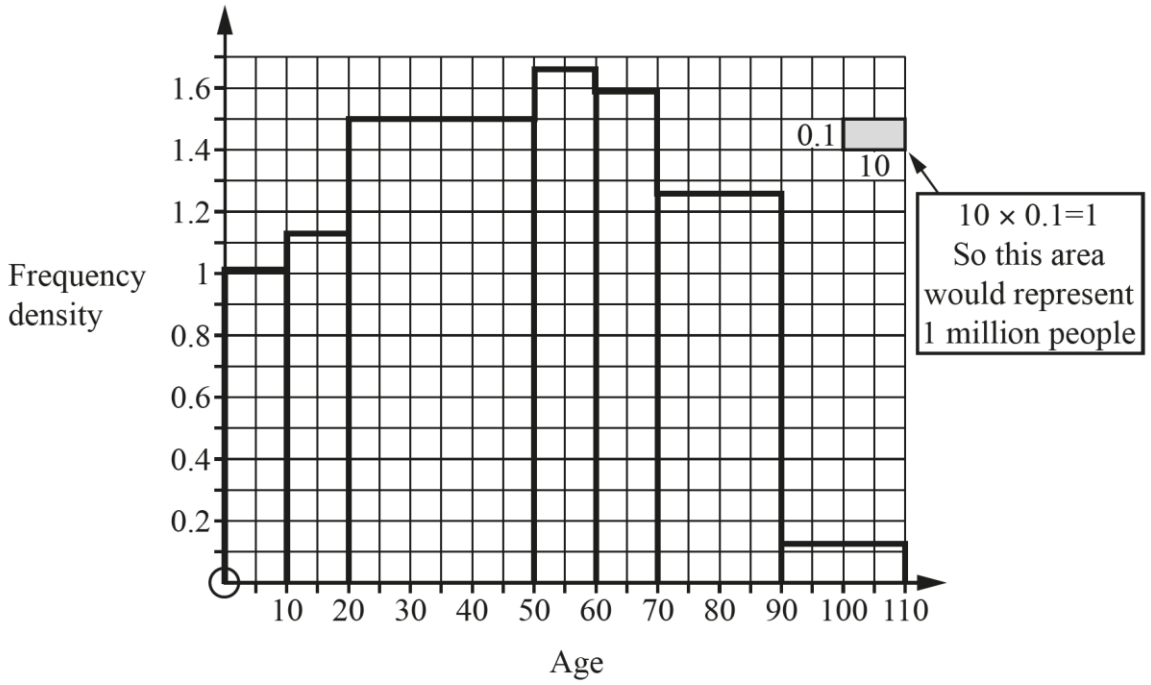
Most candidates presented a relevant calculation here, by dividing world population by number of seconds.

Question 6 (a)

6 **(a)** Write down the total population and the median age of Japan. **[1]**

The histogram in **Fig. 6** below shows the distribution of the population of Japan in seven age groups at a recent time.

Fig. 6



The heights of the bars, from left to right, are 1.01, 1.13, 1.50, 1.66, 1.59, 1.26 and 0.12. The units for frequency density are millions of people per year of age.

6(a)	**Japan**	**Population**
		Median age

To answer this question, information had to be extracted from the pre-release insert. This question was nearly always answered correctly.

Question 6 (b)

(b) Show that the number of people under 20 is approximately 21.4 million. **[1]**

Candidates who used the given values for the heights of each bar in the diagram were able to show this very easily.

Selecting and using relevant information

Selecting and using relevant information is a key part of this qualification. The heights of each bar in the histogram were stated immediately below the histogram in Question 6 (a) and again in Question 6 (e). Candidates were expected to use these given values rather than taking their own approximate readings.

Question 6 (c)

(c) Estimate the number of people over 65. **[3]**

Candidates who had read the material carefully used the given values to calculate the required estimate. Those who made their own readings from the graph could not score here as the height of each bar, stated clearly in the question, had to be used.

Question 6 (d)

Planners describe the population by dividing it into three categories.

Under 20	20 to 65	Over 65
In education	Working	Retired

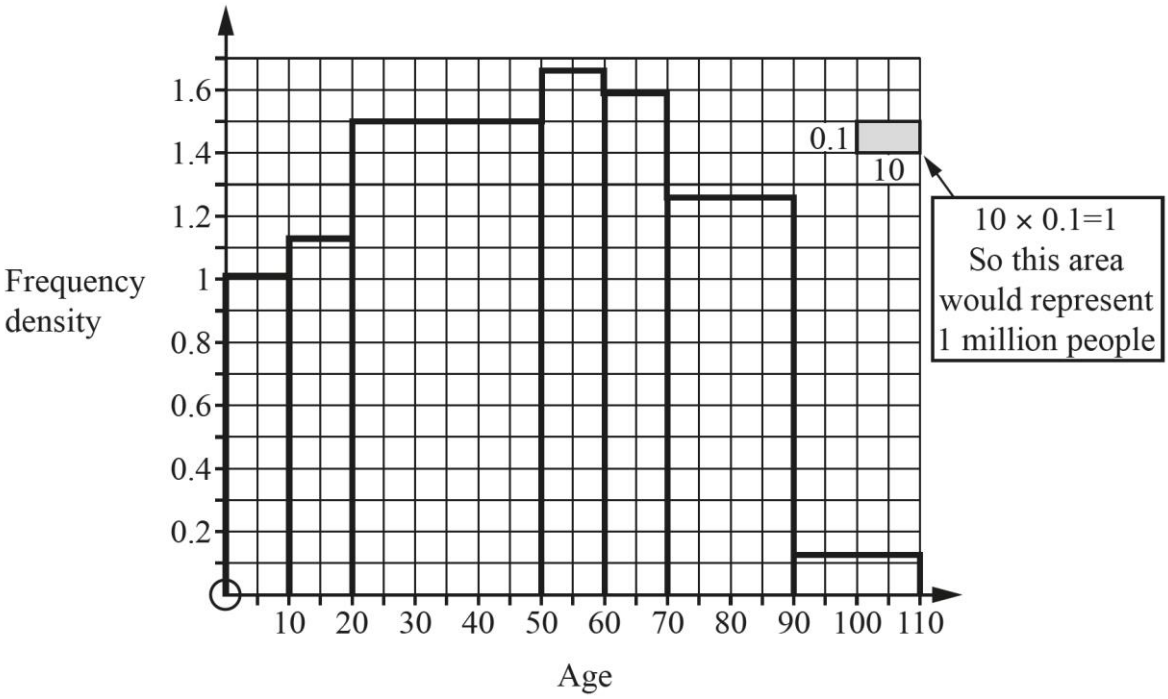
(d) Use the information in the histogram to calculate estimates for the numbers of people in each of these categories. **[1]**

6(d)	**In education**
	Working
	Retired

Many incorrect responses were seen here, including for those 'In education' which had been stated in Question 6 (b) as 21.4 million.

Question 6 (e)

Fig. 6 (repeated)



The heights of the bars, from left to right, are 1.01, 1.13, 1.50, 1.66, 1.59, 1.26 and 0.12. The units for frequency density are millions of people per year of age.

In a planning model everyone from 20 to 65 is assumed to be working, but no one else. Those in work provide financial support for people who are in education or who have retired. The support may be as family members and/or via the government through taxes.

(e) Use the model to estimate the mean number of people that a person in work is supporting financially, excluding himself or herself. **[2]**

A good proportion of candidates were given both marks here, using relevant values to form an appropriate calculation.

Question 6 (f)

In 2021 the Japanese parliament voted to raise the retirement age from 65 to 70.

(f) Using the numbers illustrated in the histogram, show that, if the retirement age is 70, the mean number of people supported by a working person is 0.63.

Comment on your answer. **[2]**

Most candidates used appropriate values to demonstrate the given result. Nearly all were able to make a sensible observation that asking people to work for longer would reduce the number of people supported by a working person.

Question 6 (g)

(g) The Netherlands are also planning to raise their retirement age. Suggest, with a brief explanation, one data value in the pre-release data for the Netherlands that could provide a reason for this. **[1]**

Most candidates were given marks here, with many choosing high life expectancy as a justification.

Copyright information

Question 3 (c): Distribution of heights in USAOnline

Question 3 (c): Population of Chicago

Statista, 'Population of Chicago' www.statista.com.

Question 3 (d): Distribution of male heights in Peru

Question 6: Data used for the histogram

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