OCR
Oxford Cambridge and RSA

Wednesday 13 October 2021 – Afternoon

AS Level Mathematics B (MEI)

H630/02 Pure Mathematics and Statistics

Time allowed: 1 hour 30 minutes

8897908823

You must have:
- the Printed Answer Booklet
- a scientific or graphical calculator

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided in the **Printed Answer Booklet**. You can use extra paper if you need to, but you must clearly show your candidate number, the centre number and the question numbers.
- Fill in the boxes on the front of the Printed Answer Booklet.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- Give your final answers to a degree of accuracy that is appropriate to the context.
- Do **not** send this Question Paper for marking. Keep it in the centre or recycle it.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **12** pages.

ADVICE
- Read each question carefully before you start your answer.

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Formulae AS Level Mathematics B (MEI) (H630)

Binomial series

$$(a+b)^n = a^n + {}^n\mathrm{C}_1 a^{n-1}b + {}^n\mathrm{C}_2 a^{n-2}b^2 + \ldots + {}^n\mathrm{C}_r a^{n-r}b^r + \ldots + b^n \qquad (n \in \mathbb{N}),$$

where ${}^n\mathrm{C}_r = {}_n\mathrm{C}_r = \binom{n}{r} = \dfrac{n!}{r!(n-r)!}$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \ldots + \frac{n(n-1)\ldots(n-r+1)}{r!}x^r + \ldots \qquad (|x| < 1,\ n \in \mathbb{R})$$

Differentiation from first principles

$$\mathrm{f}'(x) = \lim_{h \to 0} \frac{\mathrm{f}(x+h) - \mathrm{f}(x)}{h}$$

Sample variance

$$s^2 = \frac{1}{n-1}S_{xx} \text{ where } S_{xx} = \Sigma(x_i - \bar{x})^2 = \Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n} = \Sigma x_i^2 - n\bar{x}^2$$

Standard deviation, $s = \sqrt{\text{variance}}$

The binomial distribution

If $X \sim \mathrm{B}(n, p)$ then $\mathrm{P}(X = r) = {}^n\mathrm{C}_r p^r q^{n-r}$ where $q = 1 - p$

Mean of X is np

Kinematics

Motion in a straight line

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$s = \frac{1}{2}(u+v)t$

$v^2 = u^2 + 2as$

$s = vt - \frac{1}{2}at^2$

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Answer **all** the questions.

1 Find the coefficient of x^4 in the expansion of $(1+3x)^6$. **[3]**

2 Mia rolls a six-sided die 24 times and records the scores. She displays her results in a vertical line chart. This is shown in **Fig. 2.1**.

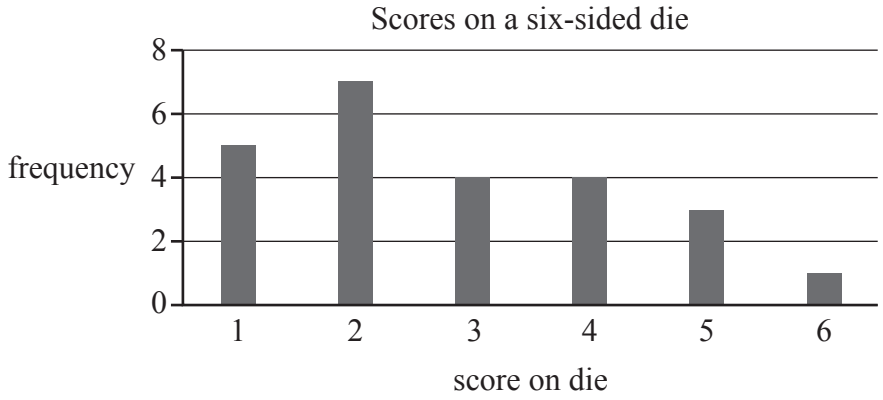


Fig. 2.1

(a) Describe the shape of the distribution. **[1]**

She repeats the experiment, but this time she rolls the die 50 times. Her results are displayed in **Fig. 2.2**.

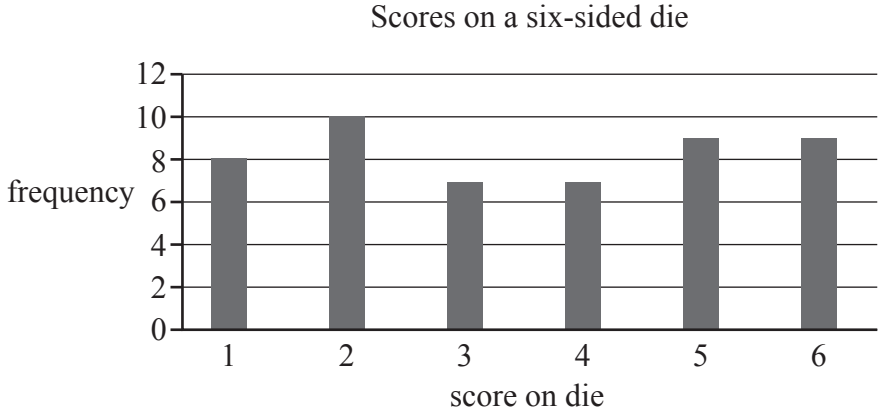


Fig. 2.2

Her brother Kai rolls the same die 1000 times and displays his results in a similar diagram.

(b) Assuming the die is fair, describe the distribution you would expect to see in Kai's diagram. **[1]**

3 **In this question you must show detailed reasoning.**

You are given that $\tan 30° = \frac{1}{\sqrt{3}}$.

Explain why $\tan 690° = -\frac{1}{\sqrt{3}}$. **[3]**

4 Find $\int\left(9x^2 + \frac{6}{\sqrt{x}}\right)\mathrm{d}x$. **[4]**

5 In 2019 scientists developed a model for comparing the ages of humans and dogs.
According to the model,

$Y = A\ln X + B$

where X = dog age in years and Y = human age in years.

For the model, it is known that when $X = 1$, $Y = 31$ and when $X = 12$, $Y = 71$.

(a) Find the value of B. **[1]**

(b) Determine the value of A, correct to the nearest whole number. **[2]**

Use the model, with the exact value of B and the value of A correct to the nearest whole number, to answer parts **(c)** and **(d)**.

(c) Find the human age corresponding to a dog age of 20 years. **[1]**

(d) Determine the dog age corresponding to a human age of 120 years. **[3]**

6 The probability distribution for the discrete random variable X is shown below.

x	0	1	2	3
$\mathrm{P}(X = x)$	$3p^2$	$0.5p^2 + 2p$	$1.5p$	$1.5p^2 + 0.5p$

(a) Determine the value of p. **[4]**

(b) Determine the modal value of X. **[2]**

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7 The pre-release material contains information about health expenditure. **Fig. 7.1** shows an extract from the data.

Country	Health expenditure (% of GDP)
Algeria	7.2
Egypt	5.6
Libya	5
Morocco	5.9
Sudan	8.4
Tunisia	7
Western Sahara	#N/A
Angola	3.3
Benin	4.6
Botswana	5.4
Burkina Faso	5

Fig. 7.1

(a) Explain how the data should be cleaned before any analysis takes place. **[1]**

Kareem uses all the available data to conduct an investigation into health expenditure as a percentage of GDP in different countries.

He calculates the mean to be 6.79 and the standard deviation to be 2.78.

Fig. 7.2 shows the smallest values and the largest values of health expenditure as a percentage of GDP.

Smallest values of Health expenditure (% of GDP)	**Largest values of Health expenditure (% of GDP)**
1.5	11.7
1.9	11.9
2.1	13.7
	13.7
	16.5
	17.1
	17.1

Fig. 7.2

(b) Determine which of these values are outliers. **[4]**

Kareem removes the outliers from the data and finds that there are 187 values left. He decides to collect a sample of size 30.

He uses the following sampling procedure.

Assign each value a number from 1 to 187.

Generate a random number, n, between 1 and 13.

Starting with the nth value, choose every 6th value after that until 30 values have been chosen.

(c) Explain whether Kareem is using simple random sampling. **[2]**

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8 With respect to an origin O, the position vectors of the points A and B are

$\overrightarrow{OA} = \begin{pmatrix} -3 \\ 20 \end{pmatrix}$ and $\overrightarrow{OB} = \begin{pmatrix} 6 \\ 8 \end{pmatrix}$.

(a) Determine whether $\left|\overrightarrow{AB}\right| > 200$. **[2]**

The point C is such that $\overrightarrow{AC} = \begin{pmatrix} 18 \\ -24 \end{pmatrix}$.

(b) Determine whether A, B and C are collinear. **[2]**

9 Arun, Beth and Charlie are investigating whether there is any association between death rate per 1000 and physician density per 1000. They each collect a random sample of size 10.

Arun's sample is shown in **Fig. 9.1**.

	death rate per 1000	physician density per 1000
Canberra	7.2	3.62
Dhaka	5.3	0.49
Brasilia	6.8	2.23
Yaounde	9.3	0.08
Zagreb	12.5	3.08
Tehran	5.4	1.16
Rome	10.7	4.14
Tripoli	3.8	2.09
Oslo	7.9	4.51
Abuja	9.7	0.35

Fig. 9.1

(a) Explain whether or not Arun collected his data from the pre-release material, or whether it is not possible to say. **[1]**

Beth and Charlie collected their samples from the pre-release material. Each of them drew a scatter diagram for their samples. The samples and scatter diagrams are shown in **Figs. 9.2** and **9.3**.

Beth's sample	death rate per 1000	physician density per 1000
Sudan	6.7	0.41
Cambodia	7.4	0.17
Gabon	6.2	0.36
Seychelles	7	0.95
Mexico	5.4	2.25
Kuwait	2.3	2.58
Haiti	7.5	0.23
Maldives	4	1.04
Nauru	5.9	1.24
Jordan	3.4	2.34

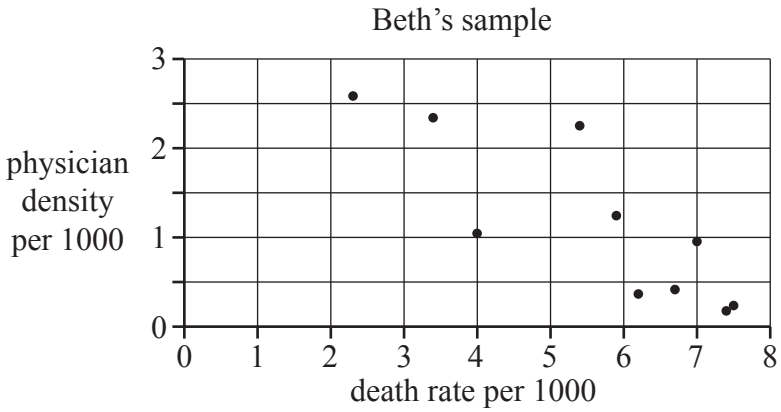


Fig. 9.2

Charlie's sample	death rate per 1000	physician density per 1000
Vanuata	4	0.17
Solomon Islands	3.8	0.2
N. Mariana Islands	4.9	0.36
Nauru	5.9	1.24
United Kingdom	9.4	2.81
Portugal	10.6	3.34
North Macedonia	9.6	2.87
Faroe Islands	8.8	2.62
Bulgaria	14.5	3.99
St. Kitts and Nevis	7.2	2.52

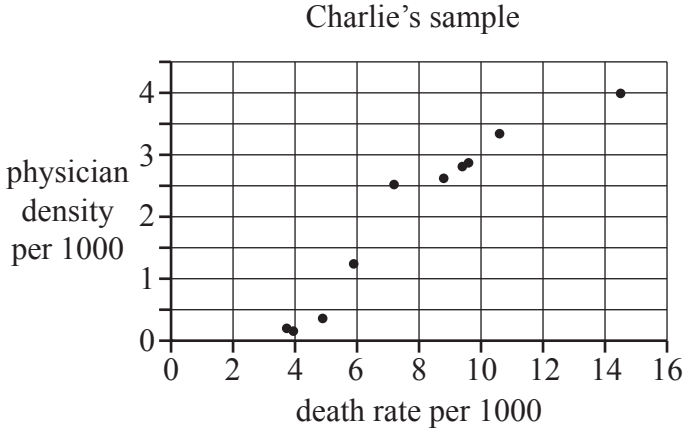


Fig. 9.3

Arun states that Charlie's sample and Beth's sample cannot **both** be random for the following reasons.

- Both samples include Nauru – there should not be any common values.
- Beth's diagram suggests a negative association between death rate and physician density, whereas Charlie's diagram suggests a positive association. If both samples are random the same relationship would be suggested.

(b)
- Explain whether Arun's reasons are valid.
- State whether or not Arun is correct, or whether it is not possible to say. **[3]**

Kofi collects a sample of 10 African countries and 10 European countries. The scatter diagram for his results is shown in **Fig. 9.4**.

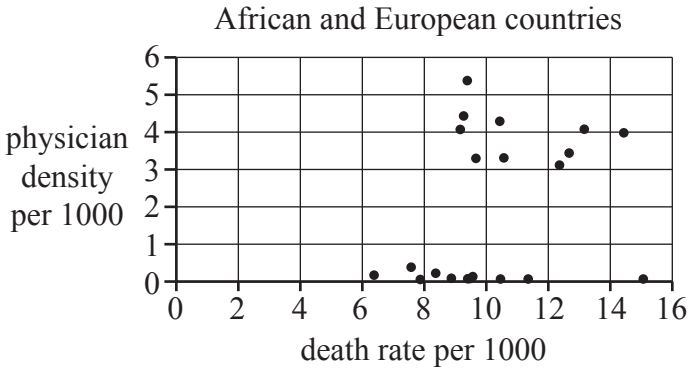


Fig. 9.4

(c) On the copy of **Fig. 9.4** in the Printed Answer Booklet, use your knowledge of the pre-release material to identify the points representing the 10 European countries, justifying your choice. **[1]**

10 In this question you must show detailed reasoning.

The points P, Q and R have coordinates $(-3, 7)$, $(11, 5)$ and $(9, -9)$ respectively.

(a) Show that PQ is perpendicular to QR. **[3]**

A circle passes through P, Q and R.

(b) Determine the coordinates of the centre of the circle. **[3]**

11 James is investigating the amount of time retired people spend each day using social media. He collects a sample by advertising in a local newspaper for people to complete an online survey.

(a) State

- the name of the sampling technique he is using,
- **one** disadvantage of using this technique. **[2]**

James processes his data in order to draw a histogram. His table of results is shown below.

Time spent using social media in minutes	0 –	15 –	30 –	60 –	120 – 240
Number of people per minute	12.2	14.0	8.4	7.3	3.1

(b) Show that the size of the sample is 1455. **[2]**

(c) Calculate an estimate of the probability that a retired person spends more than an hour per day using social media. **[2]**

12 A manufacturer of steel rods checks the length of each rod in randomly selected batches of 10 rods.

100 batches of 10 rods are checked and x, the number of rods in each batch which are too long, is recorded.

Summary statistics are as follows.

$n = 100 \qquad \Sigma x = 210 \qquad \Sigma x^2 = 604$

(a) Calculate

- the mean number of rods in a batch which are too long,
- the variance of the number of rods in a batch which are too long. **[3]**

Layla decides to use a binomial distribution to model the number of rods which are too long in a batch of 10.

(b) Write down the parameters that Layla should use in her model. **[2]**

(c) Use Layla's model to determine the expected number of batches out of 100 in which there are exactly 2 rods which are too long. **[3]**

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13 In this question you must show detailed reasoning.

The equation of a curve is $y = 3x + \frac{7}{x} - \frac{3}{x^2}$.

Determine the coordinates of the points on the curve where the curve is parallel to the line $y = 2x$.

[9]

END OF QUESTION PAPER

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