



Oxford Cambridge and RSA

**Thursday 25 May 2023 – Afternoon**

**AS Level Mathematics B (MEI)**

**H630/02 Pure Mathematics and Statistics**

**Time allowed: 1 hour 30 minutes**



**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**. If you need extra space use the lined pages at the end of the Printed Answer Booklet. The question numbers must be clearly shown.
- 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.

## Formulae AS Level Mathematics B (MEI) (H630)

### Binomial series

$$(a+b)^n = a^n + {}^n C_1 a^{n-1} b + {}^n C_2 a^{n-2} b^2 + \dots + {}^n C_r a^{n-r} b^r + \dots + b^n \quad (n \in \mathbb{N}),$$

$$\text{where } {}^n C_r = {}_n C_r = \binom{n}{r} = \frac{n!}{r!(n-r)!}$$

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

### Differentiation from first principles

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

### Sample variance

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

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

### The binomial distribution

If  $X \sim B(n, p)$  then  $P(X = r) = {}^n C_r p^r q^{n-r}$  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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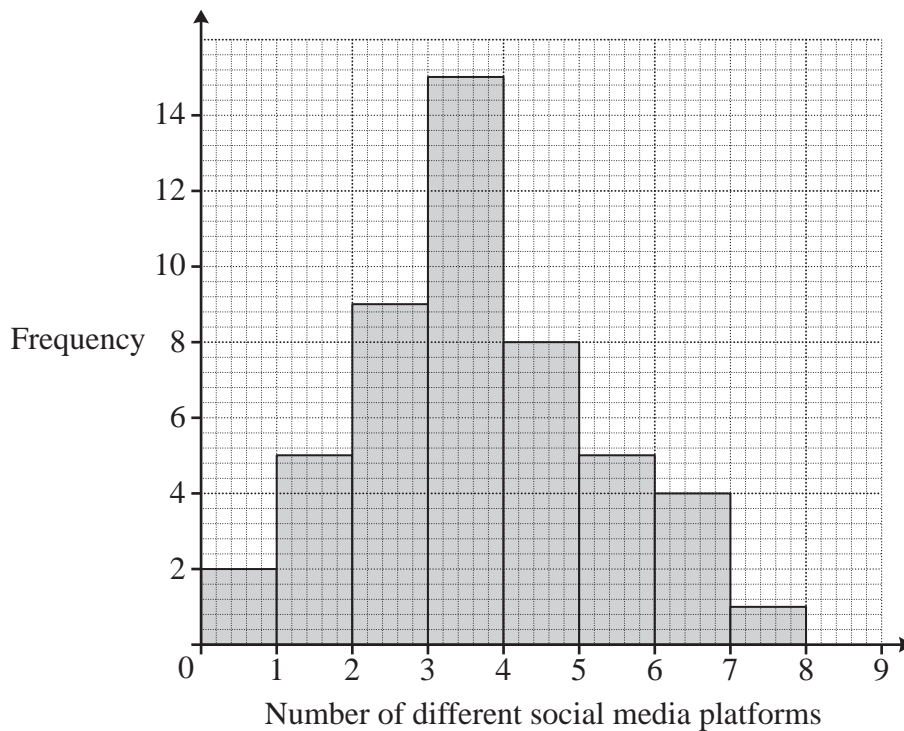
## 4

- 1 A researcher collects data concerning the number of different social media platforms used by school pupils on a typical weekday.

The frequency table for the data is shown below.

Number of different social media platforms	0	1	2	3	4	5	6	7
Frequency	2	5	9	15	8	5	4	1

The researcher uses software to represent the results in this diagram.



- (a) Explain why this diagram is inappropriate. [1]
- (b) Calculate the following for the number of social media platforms used:
- (i) the mean, [1]
- (ii) the standard deviation. [1]
- 2 (a) Express  $x^2 - 6x + 1$  in the form  $(x - a)^2 - b$ , where  $a$  and  $b$  are integers to be determined. [2]
- (b) Hence state the coordinates of the turning point on the graph of  $y = x^2 - 6x + 1$ . [1]

- 3 A student makes the following conjecture.

For all positive integers  $n$ ,  $6n - 1$  is always prime.

Use a counter example to disprove this conjecture. [2]

- 4 The equation of a curve is  $y = \frac{k}{x^2}$ , where  $k$  is a constant.

The curve passes through the point  $(2, 1)$ .

(a) Find the value of  $k$ . [1]

(b) Sketch the curve. [2]

- 5 Show that the distance between the points  $(5, 2)$  and  $(11, -1)$  is  $a\sqrt{b}$ , where  $a$  and  $b$  are integers to be determined. [3]

- 6 An app on my new smartphone records the number of times in a day I use the phone. The data for each day since I bought the phone are shown in the stem and leaf diagram.

```

1 | 9
2 | 6
3 | 8 9
4 | 0 1 2 2 3 5 6 7 9 9
5 | 1 2 2 2 3 4 5 5 7 8 9 9
6 | 0 1 1 3 9

```

Key: 3|1 means 31

(a) Explain whether these data are a sample or a population. [1]

(b) Describe the shape of the distribution. [1]

(c) Determine the interquartile range. [2]

(d) Use your answer to part (c) to determine whether there are any outliers in the lower tail. [2]

- 7 (a) Use the factor theorem to show that  $(x - 2)$  is a factor of  $x^3 + 6x^2 - x - 30$ . [1]

(b) Factorise  $x^3 + 6x^2 - x - 30$  completely. [3]

- 8 The pre-release material contains information on Pulse Rate and Body Mass Index (BMI). A student is investigating whether there is a relationship between pulse rate and BMI. A section of the available data is shown in the table.

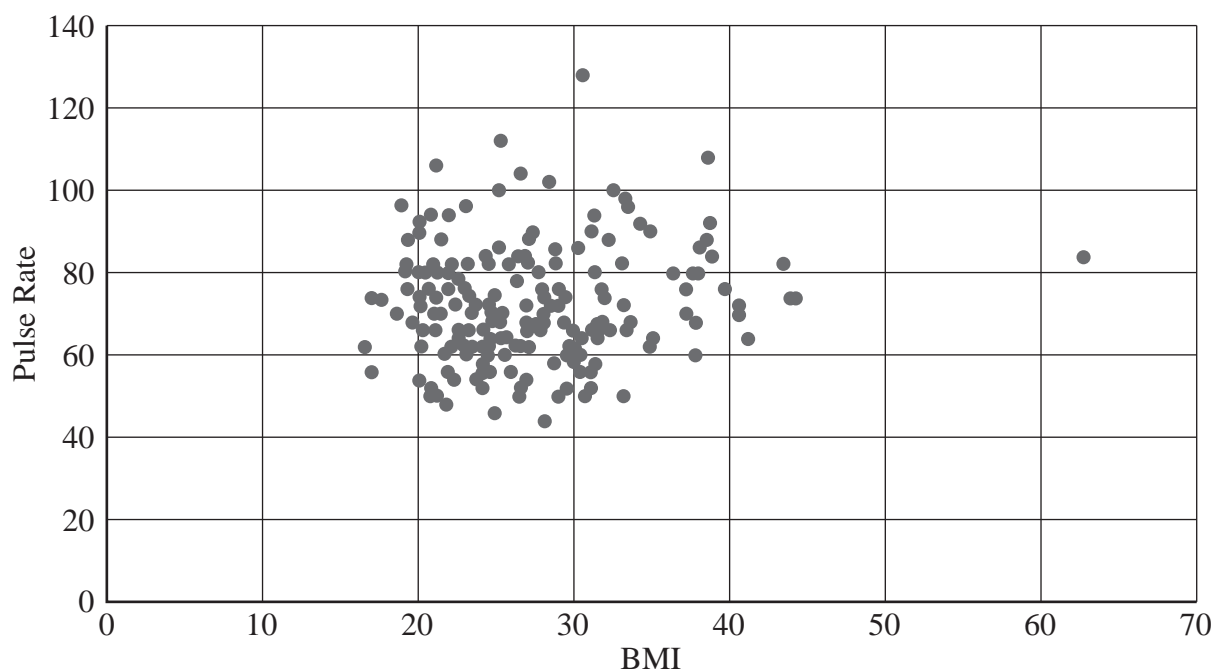
Sex	Age	BMI	Pulse
Male	62	29.54	60
Female	20	23.68	#N/A
Male	17	26.97	72
Male	35	24.7	64
Male	17	20.09	54
Male	85	23.86	54
Female	81	24.04	#N/A

The student decides to draw a scatter diagram.

- (a) With reference to the table, explain which data should be cleaned before any analysis takes place. [1]

The student cleans the data for BMI and Pulse Rate in the pre-release material and draws a scatter diagram.

Scatter diagram of Pulse Rate against BMI



The student identifies **one** outlier.

- (b) On the copy of the scatter diagram in the Printed Answer Booklet, circle this outlier. [1]

The student decides to remove this outlier from the data. They then use the LINEST function in the spreadsheet to obtain the following formula for the line of best fit.

$$P = 0.29Q + 64.2,$$

where  $P$  = Pulse Rate and  $Q$  = BMI.

They use this to estimate the Pulse Rate of a person with BMI 23.68.

They obtain a value of 71 correct to the nearest whole number.

- (c) With reference to the scatter diagram, explain whether it is appropriate to use the formula for the line of best fit. [1]

It is suggested that all pairs of values where the pulse rate is above 100 should also be cleaned from the data, as they must be incorrect.

- (d) Use your knowledge of the pre-release material to explain whether or not all pairs of values with a pulse rate of more than 100 should be cleaned from the data. [1]

- 9 The table shows the probability distribution for the discrete random variable  $X$ .

$x$	1	2	3	4	5
$P(X = x)$	0.1	0.3	$q$	$2q$	$3q$

You are given that  $q$  is a positive constant.

- (a) Determine the value of  $q$ . [2]

- (b) Calculate  $P(X \leq 4)$ . [1]

Two independent values of  $X$  are taken.

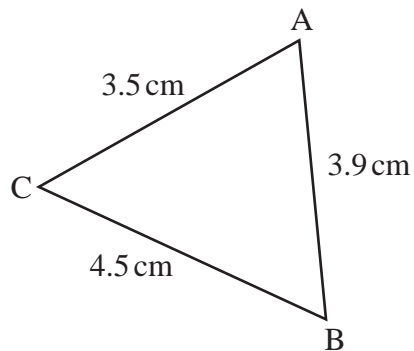
- (c) Determine the probability that the sum of the two values is 3. [2]

Fifty independent values of  $X$  are taken.

- (d) Find the probability that a value of 2 occurs exactly 17 times. [1]

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

The diagram shows triangle ABC, where  $AB = 3.9$  cm,  $BC = 4.5$  cm and  $AC = 3.5$  cm.



Determine the area of triangle ABC.

[5]

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

The equation of a curve is  $y = 2x^3 + 9x^2 + 24x - 8$ .

Show that there are no stationary points on this curve.

[5]

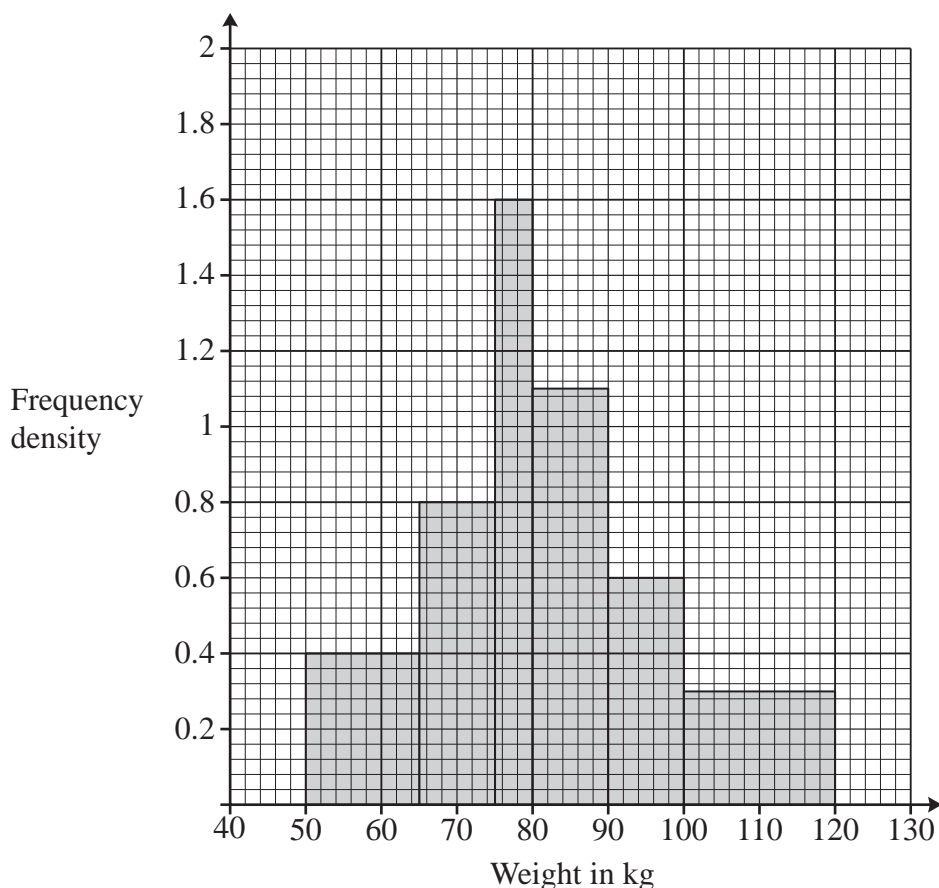


12 Doctors are investigating the weights of adult males registered at their surgery. One week they collect a sample by noting the weight in kilograms of all the adult males who have an appointment at their surgery.

(a) State the sampling method they use. [1]

(b) Explain why this method will **not** generate a simple random sample of all the adult males registered at their surgery. [1]

They represent the data using a histogram.



An incomplete frequency table for the data is shown below.

Weight in kg	50–	65–	75–	80–	90–	100–120
Frequency		8				

(c) Complete the copy of the frequency table in the Printed Answer Booklet. [1]

One of these patients is selected at random.

(d) Determine an estimate of the probability that he weighs either less than 60 kg or more than 110 kg. [2]

(e) Explain why your answer to part (d) is an estimate and not exact. [1]

**13** In a report published in October 2021 it is stated that 37% of adults in the United Kingdom never exercise or play sport. A researcher believes that the true percentage is less than this. They decide to carry out a hypothesis test at the 5% level to investigate the claim.

(a) State the null and alternative hypotheses for their test. [1]

(b) Define the parameter for their test. [1]

In a random sample of 118 adults, they find that 35 of them never exercise or play sport.

(c) Carry out the test. [4]

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

The equation of a curve is  $y = 16\sqrt{x} + \frac{8}{x}$ .

Determine the equation of the tangent to the curve at the point where  $x = 4$ . [7]

**15** A family is planning a holiday in Europe. They need to buy some euros before they go. The exchange rate,  $y$ , is the number of euros they can buy per pound. They believe that the exchange rate may be modelled by the formula

$$y = at^2 + bt + c,$$

where  $t$  is the time in days from when they first check the exchange rate.

Initially, when  $t = 0$ , the exchange rate is 1.14.

(a) Write down the value of  $c$ . [1]

When  $t = 2$ ,  $y = 1.20$  and when  $t = 4$ ,  $y = 1.25$ .

(b) Calculate the values of  $a$  and  $b$ . [2]

The family will only buy their euros when their model predicts an exchange rate of at least 1.29.

(c) Determine the range of values of  $t$  for which, according to their model, they will buy their euros. [3]

(d) Explain why the family's model is not viable in the long run. [1]

**END OF QUESTION PAPER**



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