OCR
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# Thursday 25 May 2023 – Afternoon

## AS Level Mathematics B (MEI)

### H630/02 Pure Mathematics and Statistics

**Time allowed: 1 hour 30 minutes**

*9917247140*

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

QP

**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.

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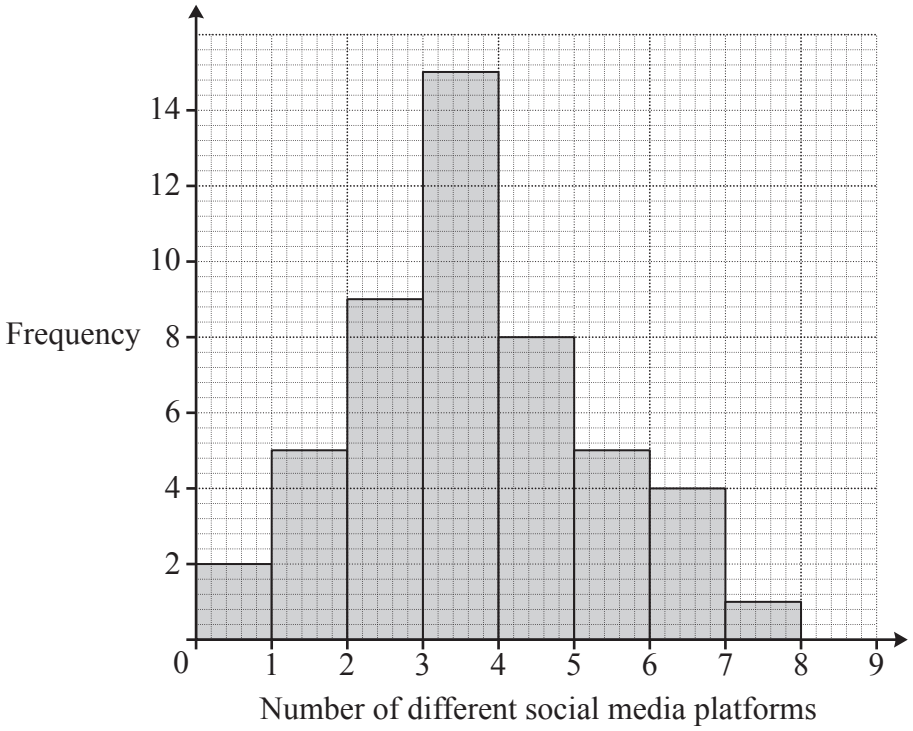
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**1** A researcher collects data concerning the number of different social media platforms used by school pupils on a typical weekday.

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]**

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**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.

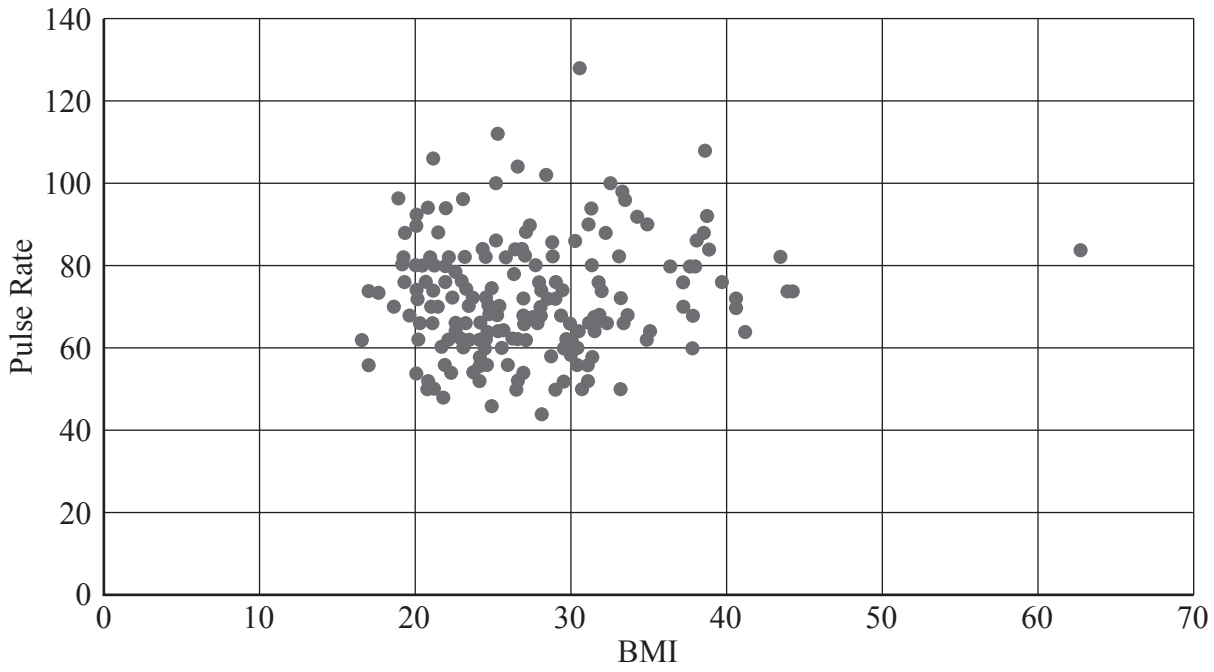
| Sex | Age | BMI | Pulse |
|---|---|---|---|
| Male | 62 | 29.54 | 60 |
| Female | 20 | 23.68 | #N/A |
| Male | 17 | 26.97 | 72 |
| Male | 35 | 24.7 | 64 |
| Male | 17 | 20.09 | 54 |
| Male | 85 | 23.86 | 54 |
| Female | 81 | 24.04 | #N/A |

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]**

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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 |
|---|---|---|---|---|---|
| $\mathrm{P}(X = x)$ | 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 $\mathrm{P}(X \leqslant 4)$. **[1]**

Two independent values of $X$ are taken.

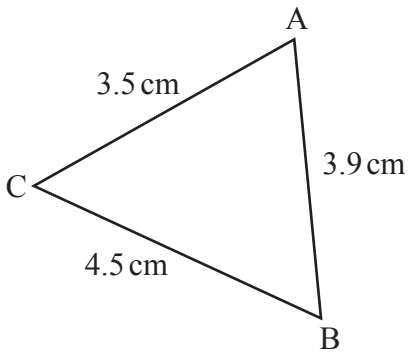
**(c)** Determine the probability that the sum of the two values is 3. **[2]**

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 $AB = 3.9\,\text{cm}$, $BC = 4.5\,\text{cm}$ and $AC = 3.5\,\text{cm}$.




Determine the area of triangle ABC. **[5]**

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

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

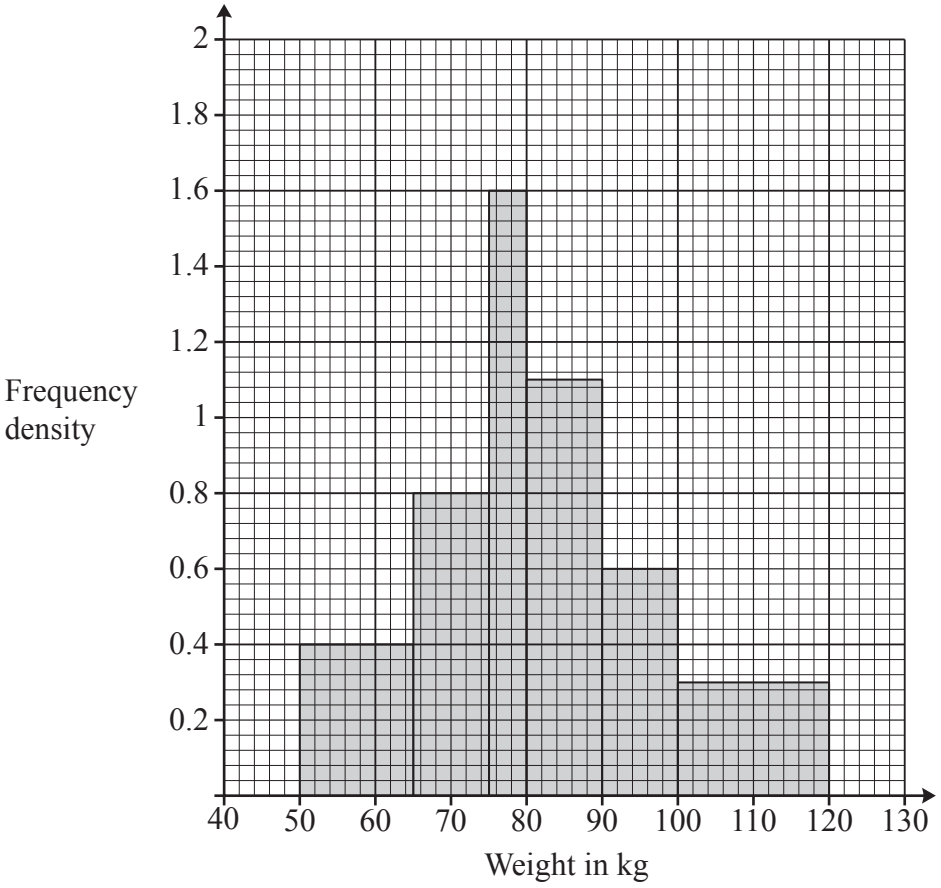
Show that there are no stationary points on this curve. **[5]**

**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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