OCR
Oxford Cambridge and RSA

Friday 23 May 2025 – Afternoon

AS Level Mathematics B (MEI)

H630/02 Pure Mathematics and Statistics

Time allowed: 1 hour 30 minutes

185721276

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

$$(a+b)^n = a^n + {}^nC_1 a^{n-1}b + {}^nC_2 a^{n-2}b^2 + \ldots + {}^nC_r a^{n-r}b^r + \ldots + b^n \qquad (n \in \mathbb{N}),$$

where ${}^nC_r = {}_nC_r = \binom{n}{r} = \dfrac{n!}{r!(n-r)!}$

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

Differentiation from first principles

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

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 $X \sim B(n, p)$ then $P(X = r) = {}^nC_r p^r q^{n-r}$ 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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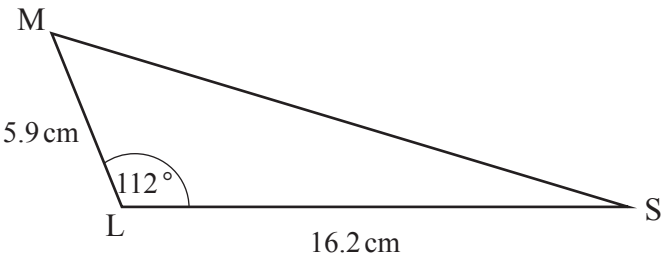
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1 You are given that b, c and d are integers greater than 1.

(a) State the value of $\left(\frac{c}{d}\right)^0$. **[1]**

(b) State the value of $\log_b b$. **[1]**

2 Triangle LMS is shown in the diagram.



LS = 16.2 cm, LM = 5.9 cm and angle MLS = 112°.

Determine the area of triangle LMS. **[2]**

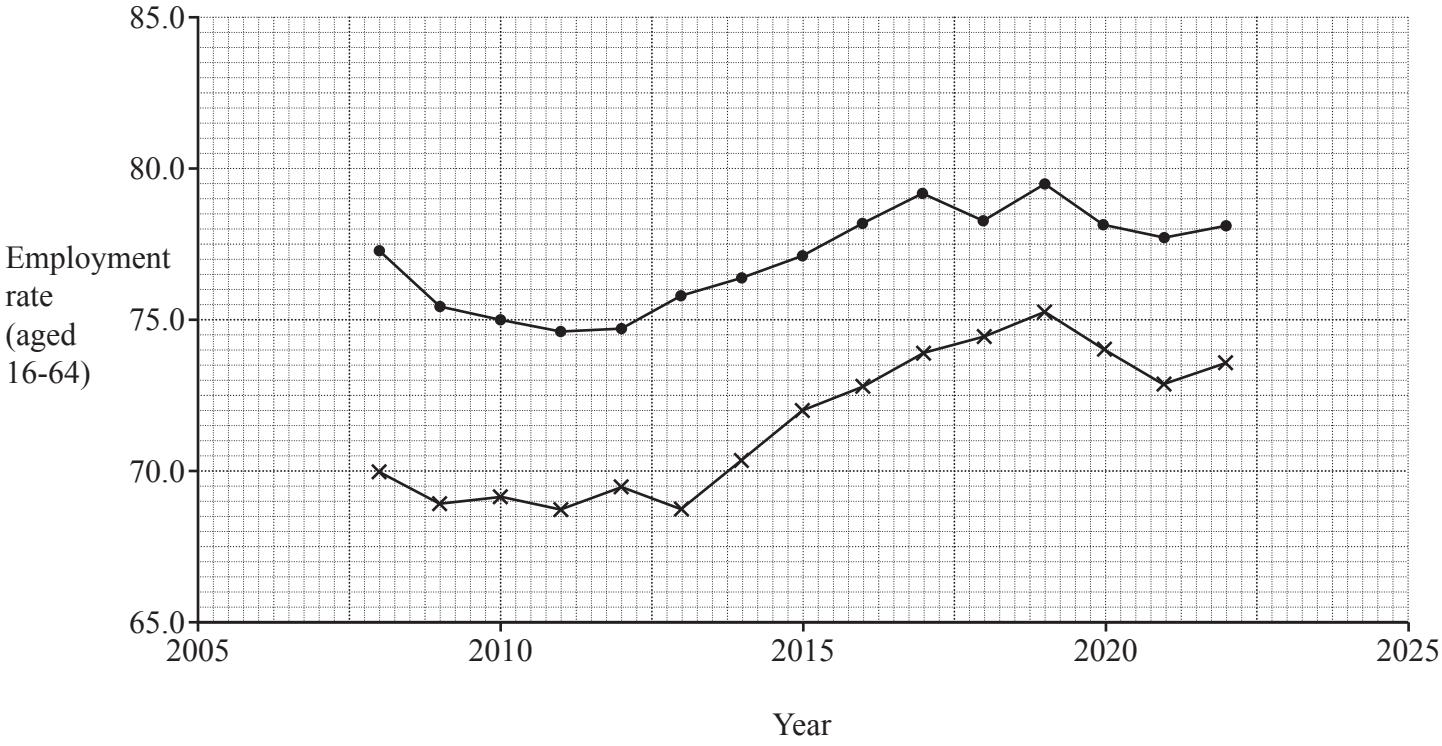
3 You are given that $5\sin\theta = 9\cos\theta$ and $0° < \theta < 360°$.

Determine the possible values of θ correct to **3** significant figures. **[2]**

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4 The pre-release material contains data for percentage employment rates in different areas of England.

The diagram shows percentage employment rates between 2008 and 2022 for the North West of England and the South East of England.



(a) Use your knowledge of the pre-release material to explain whether Series 1 (the lower time series) or Series 2 (the upper time series) represents the data for the South East of England. **[1]**

A student uses the LINEST function to model the data for Series 2.

(b) Assuming that a straight line model is reasonable, use your knowledge of the pre-release material to explain whether it would be appropriate to use this model to calculate an estimate of the percentage employment rate in Cornwall, in the South West of England, in 2011. **[1]**

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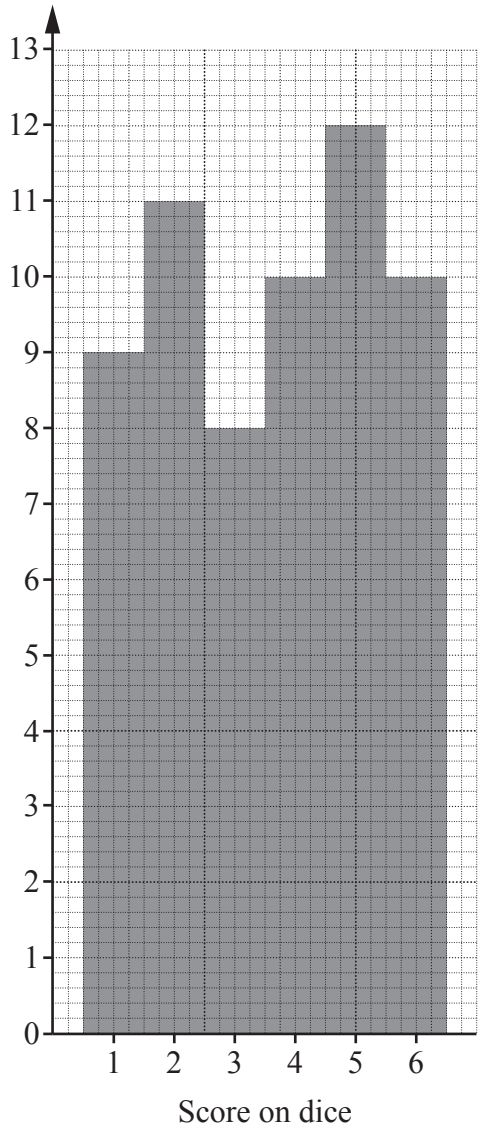
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5 All members of a class of year 9 pupils are asked to roll a **fair** dice a number of times, record the results and represent them using a suitable diagram.

Kai's diagram is shown in **Fig. 5.1**.

Fig. 5.1

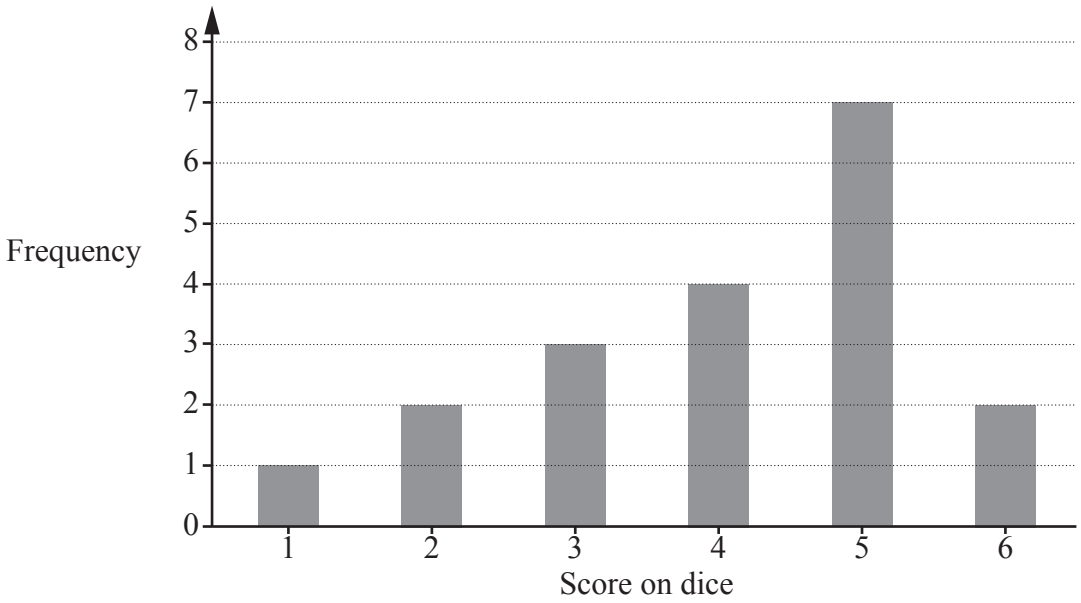


(a) Explain why Kai's diagram is unsuitable for these data. **[1]**

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Zayn's diagram is shown in **Fig. 5.2**.

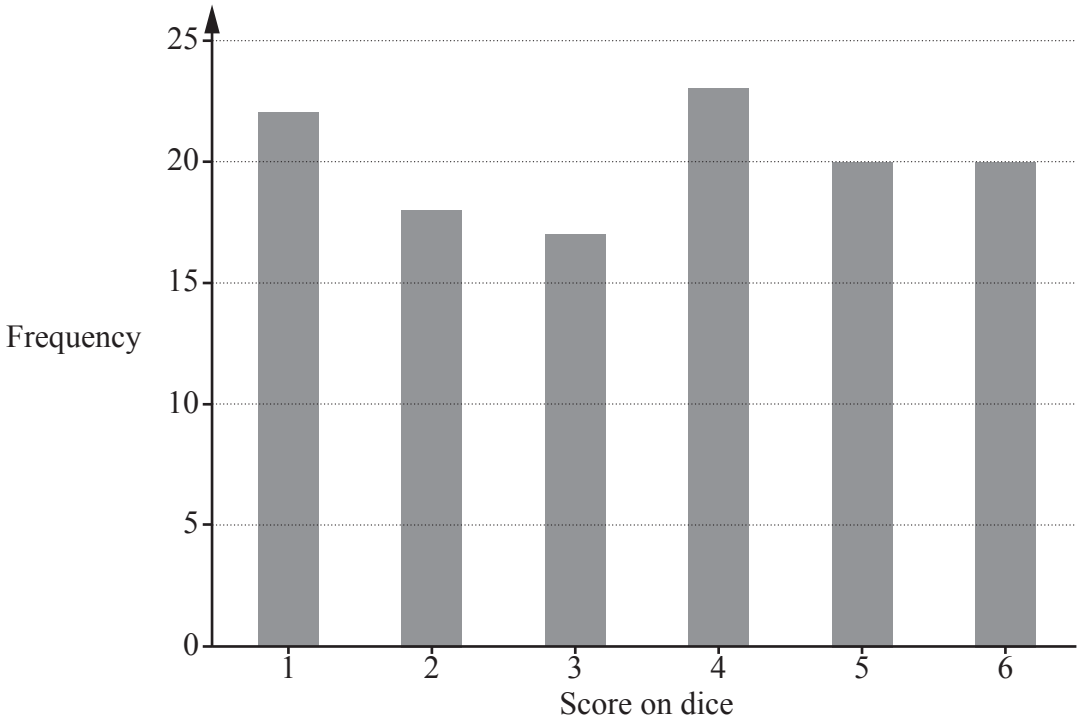
Fig. 5.2



(b) Describe the shape of the distribution in Zayn's diagram. **[1]**

Ali's diagram is shown in **Fig. 5.3**.

Fig. 5.3



(c) Explain whose diagram is likely to be the most representative of the probability distribution of the score on a fair dice. **[1]**

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6 The equation of a curve is

$y = x^4 - 8x^3 + 20.$

(a) Show that the gradient function, $\frac{dy}{dx}$, is

$\frac{dy}{dx} = 4x^2(x-6).$ **[2]**

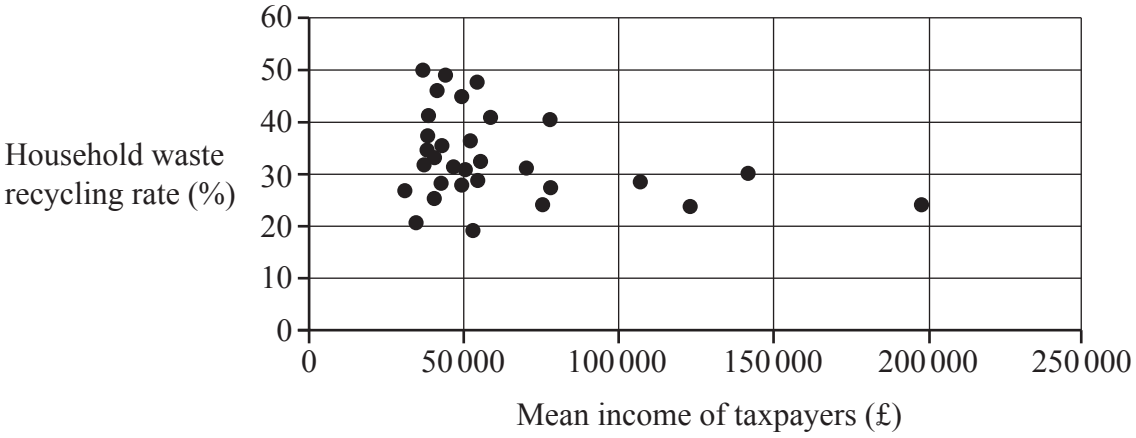
(b) **(i)** On the axes in the Printed Answer Booklet, sketch the gradient function of y. **[2]**

(ii) State the coordinates of the intercepts of the gradient function of y. **[1]**

(c) Hence state the range of values of x for which $y = x^4 - 8x^3 + 20$ is an increasing function. Express your answer in set notation. **[1]**

7 The pre-release material contains data on household waste recycling rates and mean income of taxpayers in different areas of England.

The scatter diagram shows the household waste recycling rates and mean income of taxpayers for different areas of London in 2020/21.



(a) Initially Umi thinks that the scatter diagram suggest that there is some negative correlation between household recycling rates and mean income of taxpayers.

Explain why Umi might believe this is the case. **[1]**

Having inspected the diagram more closely, Umi believes that there are **4** outliers.

(b) On the copy of the diagram in the **Printed Answer Booklet**, circle these four outliers. **[1]**

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The table below shows further analysis of mean income of taxpayers and household waste recycling rates in 2020/21 in areas of London.

	Lower Quartile	Upper Quartile
Mean income of taxpayers (£)	40 350	64 300
Household waste recycling rate (%)	27.80	38.85

(c) Use a suitable calculation to explain whether or not this information supports Umi's statement. **[2]**

Umi removes all 4 points which they believe represent outliers and draws a new scatter diagram.

(d) Describe the correlation between household waste recycling rates and mean income of taxpayers in London suggested by Umi's **new** diagram. **[1]**

8 The probability function of a discrete random variable X is

$$\mathrm{P}(X = r) = \frac{k}{r},\ r = 1, 2, 3, 4,$$

where k is a constant.

(a) Determine the value of k. **[2]**

Two independent readings of X are taken. These are denoted by X_1 and X_2.

(b) Determine $\mathrm{P}(X_1 + X_2 = 7)$. **[2]**

9 A triangular number is any number of the form $\frac{n(n+1)}{2}$, where n is a positive integer.

Prove that the sum of any **two consecutive** triangular numbers is a perfect square. **[3]**

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10 Two market researchers, Riley and Ryan, are commissioned by a supermarket to investigate the total amount spent by shoppers in a single transaction.

Riley is instructed to collect data from 25 shoppers aged 18–39 and 25 shoppers aged 40–65.

Ryan is instructed to collect data from 30 shoppers aged 40–65 and 20 shoppers aged over 65.

(a) State the sampling method Riley and Ryan are using. **[1]**

(b) Explain whether this sampling method is random. **[1]**

The mean amount spent for each group is shown in the table.

	Riley's data		Ryan's data	
Age	18–39	40–65	40–65	over 65
Sample Size	25	25	30	20
Mean Amount Spent	£93.21	£38.22	£87.34	£65.22

(c) Find the mean of all the 100 transactions. **[2]**

A member of the supermarket management team states that one of the mean amounts for the 40–65 age group must be wrong.

(d) Explain why there is insufficient evidence to support this statement. **[1]**

11 A circle has centre (4, –1) and radius 13.

(a) Write down the equation of the circle. **[2]**

(b) Determine the equation of the tangent to the circle at the point (9, 11). **[4]**

12 The equation of a curve is $\mathrm{f}(x) = 3x^2 + 2x$.

(a) Determine an expression for the gradient of the chord joining the points $(a, \mathrm{f}(a))$ and $(a+h, \mathrm{f}(a+h))$. Express your answer as simply as possible in terms of a and h. **[3]**

(b) Use your answer to part **(a)** to determine an expression for the gradient of $\mathrm{f}(x)$ at the point where $x = a$. **[1]**

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13 In this question you must show detailed reasoning

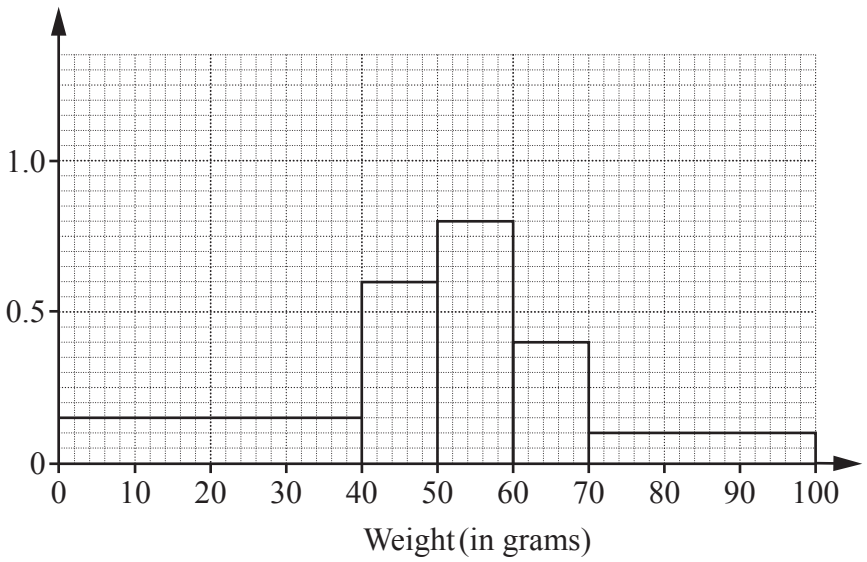
Determine the **exact** value of

$$\int_1^8 \left(\frac{6}{(\sqrt{x})^3} + \frac{2}{x^2} \right) \mathrm{d}x,$$

giving your answer in its simplest form. **[6]**

14 An environmental scientist is monitoring the fish population in a river. One day he catches some fish from a certain pool on the river. He weighs each fish before returning them all unharmed to the river.

The results are displayed in the histogram.



(a) Use the information in the histogram to determine an estimate of the percentage of fish in the river that weigh at least 40 grams. **[3]**

(b) Identify a limitation of your answer to part **(a)**. **[1]**

15 (a) On the axes in the Printed Answer Booklet, sketch the graph of $y = 3^x$. **[2]**

(b) Determine the **exact** coordinates of the points of intersection of the curve $y = 3^x$ with the curve $y = 3^{2x} - 6 \times 3^x + 12$. **[5]**

Turn over for question 16

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16 According to government statistics, 6.45% of people in Britain are vegetarian.

A researcher believes the percentage of people who are vegetarian in the village where she lives might be different.

There are 484 people living in this village.

The researcher randomly selects 78 people from the village and establishes that 12 of them are vegetarian.

(a) Explain whether the 78 people selected form a sample or a population. **[1]**

(b) Conduct a hypothesis test at the 5% level to determine whether there is any evidence to support the researcher's belief that the percentage of people in her village who are vegetarian is different to 6.45%. **[7]**

(c) State the probability that the null hypothesis is incorrectly rejected. **[1]**

END OF QUESTION PAPER

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Surname	StemUp Model Solution
Answer booklet	Write the question number in the left-hand margin at the start of each answer.

Question number

1 (a) $\left(\frac{c}{d}\right)^0 = 1$

1 (b) $\log_b b = 1$

2 $\text{Area} = \frac{1}{2} \times 5.9 \times 16.2 \times \sin 112°$

$= 44.3101...$

$\text{Area} = 44.3 \text{ cm}^2$ (3 s.f.)

3 $5 \sin\theta = 9 \cos\theta$

$\tan\theta = \frac{9}{5} = 1.8$

$\theta = \tan^{-1}(1.8) = 60.945...°$ or $\theta = 60.945...° + 180° = 240.945...°$

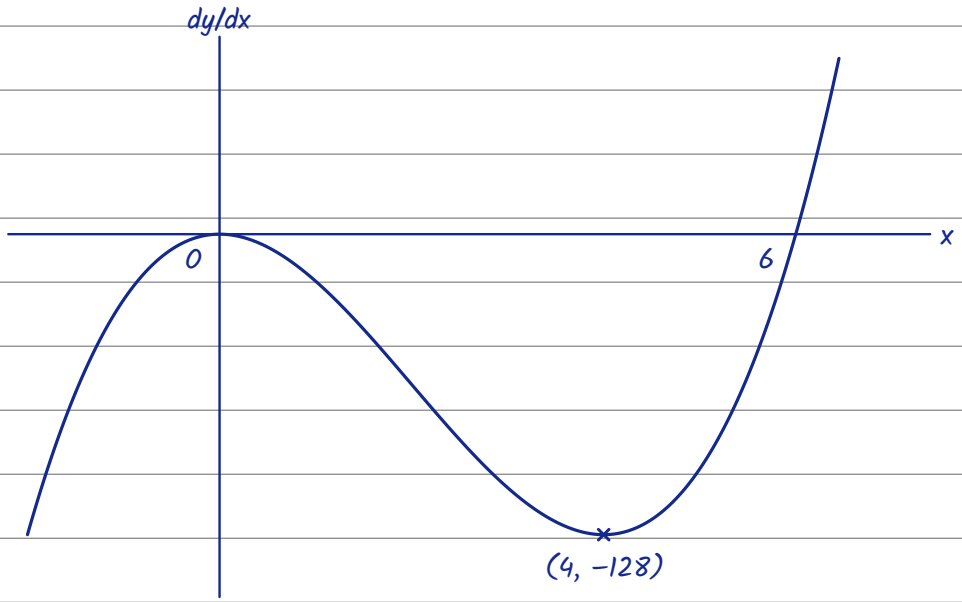
$\theta = 60.9°, 241°$ (3 s.f.)

4 (a) Series 2 represents the South East of England, because employment rates are generally higher in the South East than in the North West.

4 (b) Not appropriate: the model is based on South East data, and (the pattern of) employment rates are different in different areas of England, so it should not be used for Cornwall in the South West.

5 (a) The scores on a dice are discrete data, but Kai has drawn a histogram (bars touching), which is only suitable for continuous data.

Question number	
5 (b)	Negatively skewed
5 (c)	Ali's diagram (Fig. 5.3), because Ali rolled the dice the most number of times (120 rolls), so the frequencies are closest to the discrete uniform distribution of a fair dice.
6 (a)	$y = x^4 - 8x^3 + 20$ $dy/dx = 4x^3 - 24x^2$ $= 4x^2(x - 6)$ as required
6 (b)(i)	$dy/dx = 4x^2(x - 6)$

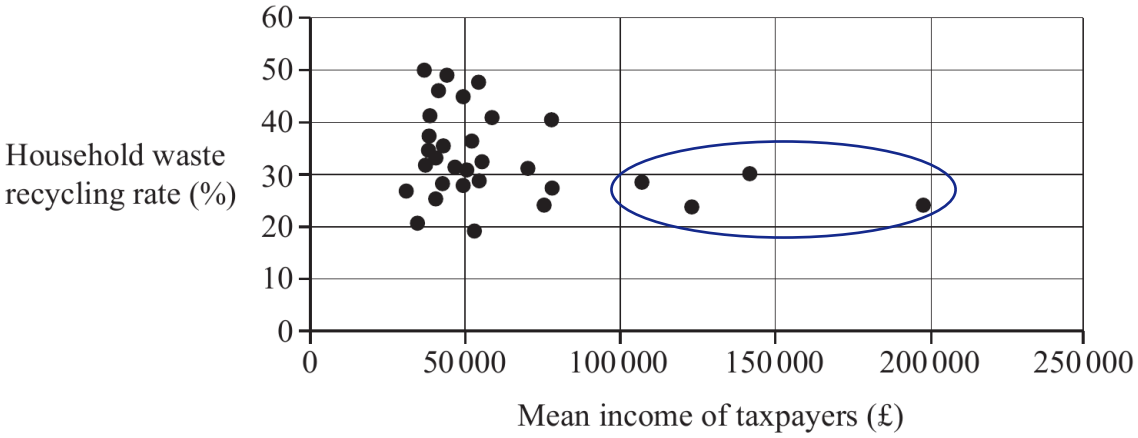


6 (b)(ii)	$4x^2(x - 6) = 0 \Rightarrow x = 0$ (repeated) or $x = 6$; at $x = 0$, $dy/dx = 0$ Intercepts: (0, 0) and (6, 0)
6 (c)	Increasing when $dy/dx > 0$, i.e. $4x^2(x - 6) > 0 \Rightarrow x > 6$ $\{x : x > 6\}$
7 (a)	Because it appears that as the mean income increases, the household waste

Question number

7 cont. recycling rate decreases.

7 (b)



7 (c) IQR = 64300 − 40350 = 23950

Upper fence = 64300 + 1.5 × 23950 = 64300 + 35925 = 100225

The 4 outliers all have mean income greater than £100225, so they are outliers by this definition. This supports Umi's statement.

7 (d) Weak / no correlation

8 (a) $k\left(\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4}\right) = 1 \Rightarrow \frac{25}{12}k = 1$

$k = \frac{12}{25}$

8 (b) $X_1 + X_2 = 7 \Rightarrow (3, 4)$ or $(4, 3)$

$P(X = 3) = \frac{k}{3} = \frac{4}{25}$, $P(X = 4) = \frac{k}{4} = \frac{3}{25}$

$P(X_1 + X_2 = 7) = 2 \times \frac{4}{25} \times \frac{3}{25} = \frac{24}{625} = 0.0384$

Question number	
9	Let the two consecutive triangular numbers be $\frac{n(n+1)}{2}$ and $\frac{(n+1)(n+2)}{2}$, n a positive integer $\text{Sum} = \frac{n(n+1)}{2} + \frac{(n+1)(n+2)}{2} = \frac{(n+1)}{2} \times (n + n + 2)$ $= \frac{(n+1)}{2} \times 2(n+1) = (n+1)^2$ $n + 1$ is an integer, so $(n+1)^2$ is a perfect square. So the sum of any two consecutive triangular numbers is a perfect square.
10 (a)	Quota sampling
10 (b)	Not random, because Riley and Ryan choose which shoppers to select, so not all shoppers have an equal chance of being chosen.
10 (c)	$\text{Mean} = \frac{25 \times 93.21 + 25 \times 38.22 + 30 \times 87.34 + 20 \times 65.22}{100}$ $= \frac{7210.35}{100} = 72.1035 = £72.10$
10 (d)	Different samples can lead to different results, so two samples from the same age group can have very different means; the difference does not mean either value is wrong.
11 (a)	$(x-4)^2 + (y+1)^2 = 169$
11 (b)	Gradient of radius $= \frac{11-(-1)}{9-4} = \frac{12}{5}$

Question number

11 cont.

Gradient of tangent $= -\frac{5}{12}$ (perpendicular to radius)

$y - 11 = -\frac{5}{12}(x - 9)$

$12y - 132 = -5x + 45$

$5x + 12y = 177$

12 (a)

Gradient $= \frac{f(a+h) - f(a)}{(a+h) - a} = \frac{3(a+h)^2 + 2(a+h) - 3a^2 - 2a}{h}$

$= \frac{3a^2 + 6ah + 3h^2 + 2a + 2h - 3a^2 - 2a}{h}$

$= \frac{6ah + 3h^2 + 2h}{h} = 6a + 3h + 2$

12 (b)

As $h \to 0$, $6a + 3h + 2 \to 6a + 2$

Gradient of $f(x)$ at $x = a$ is $f'(a) = 6a + 2$

13

$\int_1^8 \left(\frac{6}{(\sqrt{x})^3} + \frac{2}{x^2} \right) dx = \int_1^8 (6x^{-3/2} + 2x^{-2})\, dx$

$= \left[\frac{6x^{-1/2}}{-1/2} + \frac{2x^{-1}}{-1} \right]_1^8 = \left[-12x^{-1/2} - 2x^{-1} \right]_1^8$

$= \left(-\frac{12}{\sqrt{8}} - \frac{2}{8} \right) - \left(-\frac{12}{\sqrt{1}} - \frac{2}{1} \right)$

$= -\frac{12}{2\sqrt{2}} - \frac{1}{4} + 14 = -3\sqrt{2} + \frac{55}{4}$

$= \frac{55}{4} - 3\sqrt{2}$

14 (a)

Frequency = frequency density × class width

Question number

14 cont. 0 to 40: $40 \times 0.15 = 6$ 40 to 50: $10 \times 0.6 = 6$ 50 to 60: $10 \times 0.8 = 8$

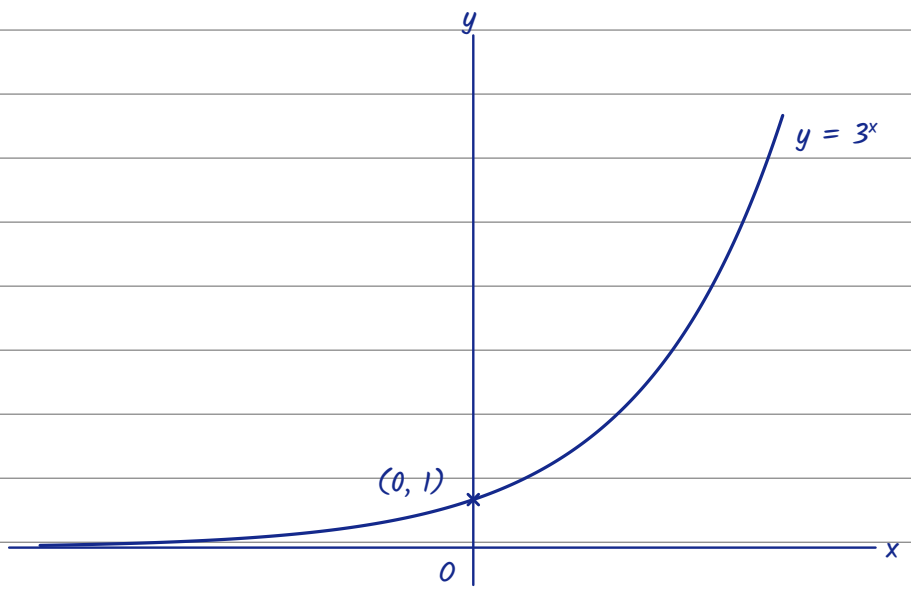
60 to 70: $10 \times 0.4 = 4$ 70 to 100: $30 \times 0.1 = 3$

$$\% \text{ at least } 40\text{ g} = \frac{10 \times 0.6 + 10 \times 0.8 + 10 \times 0.4 + 30 \times 0.1}{40 \times 0.15 + 10 \times 0.6 + 10 \times 0.8 + 10 \times 0.4 + 30 \times 0.1} \times 100$$

$$= \frac{21}{27} \times 100 = \frac{7}{9} \times 100 = 77.777\ldots = 77.8\%$$

14 (b) The fish were caught from just one pool on one day, and fish in this pool may not be typical of the fish in the whole river.

15 (a)



15 (b) $3^{2x} - 6 \times 3^x + 12 = 3^x$

$(3^x)^2 - 7(3^x) + 12 = 0$ Let $u = 3^x$: $u^2 - 7u + 12 = 0$

$(u - 3)(u - 4) = 0 \Rightarrow 3^x = 3$ or $3^x = 4$

$x = 1$ or $x = \log_3 4$ $\left(= \frac{\ln 4}{\ln 3} \right)$

$y = 3^x$: $x = 1 \Rightarrow y = 3$; $x = \log_3 4 \Rightarrow y = 4$

Points of intersection: $(1, 3)$ and $(\log_3 4, 4)$

Question number	
16 (a)	A sample, since not all of the 484 people in the village were selected (only 78 of them).
16 (b)	H_0: $p = 0.0645$ H_1: $p \neq 0.0645$ where p is the probability that a person selected at random from the village is a vegetarian. Let X be the number of vegetarians in the sample of 78 Under H_0, $X \sim B(78, 0.0645)$ Two-tailed test at 5%: compare with 0.025 in each tail $E(X) = 78 \times 0.0645 = 5.031$, and $12 > 5.031$ so use the upper tail $P(X \geqslant 12) = 1 - P(X \leqslant 11) = 0.004163... = 0.0042$ $0.0042 < 0.025$, so the result is significant: reject H_0 There is sufficient evidence at the 5% level to suggest that the probability that a person selected at random from the village is a vegetarian is not 0.0645.
16 (c)	$P(H_0$ incorrectly rejected) = significance level = 0.05