



Edexcel AS Mathematics

8MA0/21 - Statistics

Thursday 23 May 2024

Questions and Fully Worked Model Solutions

This booklet places the **question and the solution together**. The mathematics is set out using proper fractions, powers, roots and exact notation, with extra written explanation so that a student can see *why* each step is being taken.

Solutions have been checked against the Pearson Edexcel Summer 2024 mark scheme. The aim is a clear **full-mark model response**, not merely a list of final answers.

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Question 1

Question 1

A coach recorded the heights of some adult rugby players and found the following summary statistics:

$$\text{median} = 1.85 \text{ m}, \quad \text{range} = 0.28 \text{ m}, \quad \text{interquartile range} = 0.11 \text{ m}.$$

The shortest player is 1.72 m tall, and 25% of the players have heights below 1.81 m. Draw a box-and-whisker plot to represent this information.

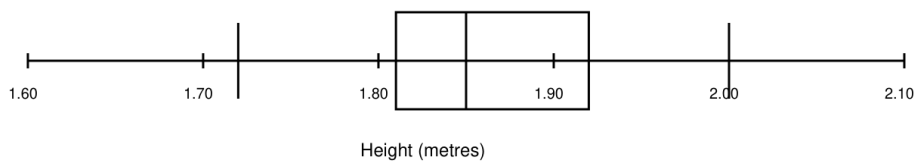
Model solution

The lower quartile is $Q_1 = 1.81 \text{ m}$. Hence

$$Q_3 = Q_1 + \text{IQR} = 1.81 + 0.11 = 1.92 \text{ m}.$$

The minimum is 1.72 m, so the maximum is

$$1.72 + 0.28 = 2.00 \text{ m}.$$



Box plot with minimum 1.72, lower quartile 1.81, median 1.85, upper quartile 1.92, and maximum 2.00, all in metres.

(4)

Question 2

Question 2

Keith is studying the variable Daily Mean Wind Direction, in degrees, from the large data set. He summarised the data for Camborne from 1987 into four directions A, B, C, D, representing North, South, East and West in some order.

Direction	A	B	C	D
Frequency	22	48	56	58

- (a) Using your knowledge of the large data set, state, giving a reason, which direction A represents. The entry for Hurn on 27 September 1987 was 999.
 (b) State, giving a reason, what Keith should do with this value.

Model solution

(a) The frequency for A is the lowest. Winds from the east are least common at Camborne (and more generally in the UK), so A represents East.

A = East, since easterly winds are the least frequent.

((a) 1)

(b) A wind direction in degrees must be between 0° and 360° . Since 999 is outside this possible range, it is an invalid data value and must not be included in the analysis.

Discard/remove the value 999, as it cannot be a wind direction in degrees.

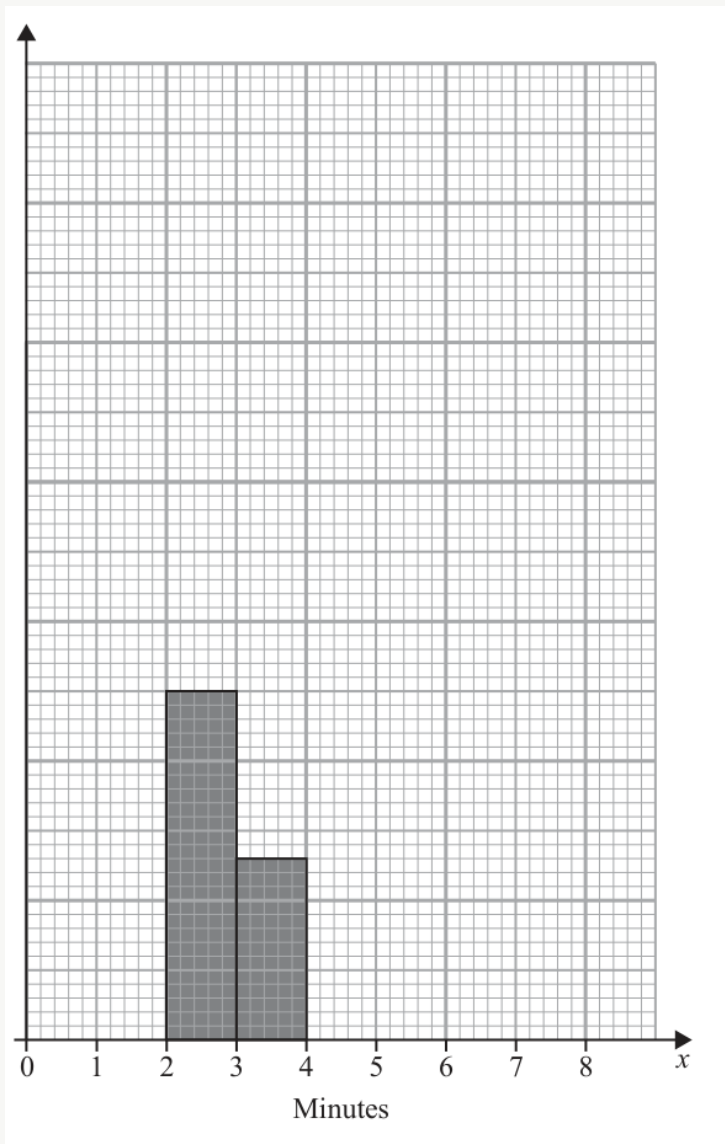
((b) 2)

Question 3

Question 3

Customers in a shop have to queue to pay. The table and histogram give information about the time x minutes spent in the queue by each of 112 customers on one day.

Time in queue (minutes)	Frequency
1–2	64
2–3	
3–4	13
4–6	
6–8	3



No customer spent less than 1 minute or longer than 8 minutes in the queue.

- Complete the table.
- Complete the histogram.

Find a model for the frequency density for these 112 customers by

$$y = \frac{k}{x^2}, \quad 1 \leq x \leq 8,$$

where k is a constant.

(c) Find k .

Model solution

(a) From the histogram, the frequency density for $2 \leq x < 3$ is 25. Its class width is 1, so its frequency is 25. The frequencies must total 112, so

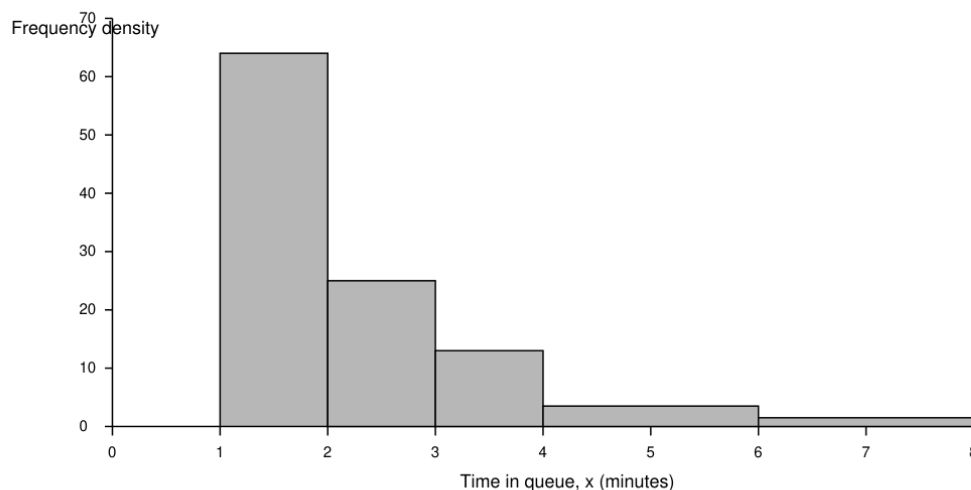
$$f_{4-6} = 112 - (64 + 25 + 13 + 3) = 7.$$

$$f_{2-3} = 25, f_{4-6} = 7.$$

((a) 2)

(b) Frequency density is $\frac{\text{frequency}}{\text{class width}}$. Thus the three missing bar heights are

$$\frac{64}{1} = 64 \quad \text{for } 1 \leq x < 2, \quad \frac{7}{2} = 3.5 \quad \text{for } 4 \leq x < 6, \quad \frac{3}{2} = 1.5 \quad \text{for } 6 \leq x \leq 8.$$



Histogram with frequency densities 64, 25, 13, 3.5, 1.5 for the successive classes.

((b) 2)

(c) The area under a frequency-density curve is the total frequency, so

$$\int_1^8 \frac{k}{x^2} dx = 112.$$

$$k \left[-\frac{1}{x} \right]_1^8 = k \left(-\frac{1}{8} + 1 \right) = \frac{7k}{8} = 112.$$

$$k = 112 \times \frac{8}{7} = 128.$$

$$k = 128.$$

((c) 3)

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Question 4

Question 4

The random variable $X \sim B(27, 0.35)$.

(a) Find (i) $P(X = 10)$; (ii) $P(12 \leq X < 15)$.

Historical records show that the proportion of defective items produced by a machine is 0.12. Following a maintenance service, a random sample of 60 items is taken and 3 defective items are found.

(b) Carry out a suitable test to determine whether the proportion of defective items has decreased following the maintenance service. State the hypotheses clearly and use a 5% level of significance.

(c) Write down the p-value for the test in part (b).

Model solution

(a)(i)

$$P(X = 10) = \binom{27}{10} (0.35)^{10} (0.65)^{17} = 0.153588 \dots$$

(i) 0.154 (3 s.f.).

((a)(i) 1)

(a)(ii) The required values are 12, 13 and 14, so

$$P(12 \leq X < 15) = P(X \leq 14) - P(X \leq 11)$$

$$= 0.97707 \dots - 0.797603 \dots = 0.17947 \dots$$

(ii) 0.179 (3 s.f.).

((a)(ii) 2)

(b) Let p be the true proportion of defective items after maintenance. The claim is that this proportion has decreased, so a lower-tailed test is required:

$$H_0 : p = 0.12, \quad H_1 : p < 0.12.$$

Under H_0 , if D is the number of defective items in a random sample of 60, then

$$D \sim B(60, 0.12).$$

The observed value is $D = 3$. The lower-tail probability is

$$P(D \leq 3) = 0.06013 \dots$$

Since $0.06013 \dots > 0.05$, the result is not significant at the 5% level, so do not reject H_0 .

There is insufficient evidence that the proportion of defective items has decreased following maintenance.

((b) 4)

$p\text{-value} = 0.0601 \dots$ (*approximately 0.060*).

((c) 1)

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Question 5

Question 5

A biased four-sided spinner has the numbers 6, 7, 8, 10. The random variable X , the score from one spin, has distribution

x	6	7	8	10
$P(X = x)$	0.5	0.2	q	q

where q is a probability.

(a) Find q .

Karen spins the spinner repeatedly until she either gets a 7 or has taken 4 spins.

(b) Show that the probability that Karen stops after her third spin is 0.128.

The random variable S represents the number of spins Karen takes.

(c) Find the probability distribution for S .

The random variable N represents the number of times Karen gets a 7.

(d) Find $P(S > N)$.

Model solution

(a) The probabilities sum to 1, so

$$0.5 + 0.2 + q + q = 1 \Rightarrow 2q = 0.3.$$

$$q = 0.15.$$

((a) 1)

(b) Karen stops after the third spin exactly when the first two spins are not 7, and the third spin is 7. Since $P(\text{not } 7) = 0.8$,

$$P(S = 3) = 0.8 \times 0.8 \times 0.2 = 0.128.$$

$$P(S = 3) = 0.128, \text{ as required.}$$

((b) 2)

(c) To stop on spins 1, 2, 3, the first 7 must occur on that spin. To take four spins, no 7 can occur in the first three spins; the outcome of the fourth spin is then irrelevant.

s	1	2	3	4
$P(S = s)$	0.2	$0.8(0.2)$	$0.8^2(0.2)$	0.8^3
	0.2	0.16	0.128	0.512

$$P(S = 1) = 0.2, P(S = 2) = 0.16, P(S = 3) = 0.128, P(S = 4) = 0.512.$$

((c) 4)

(d) If a 7 occurs, then $N = 1$ and $S \geq 1$; $S > N$ fails only when a 7 occurs on the first spin. If no 7 occurs, then $S = 4$ and $N = 0$, so $S > N$. Hence

$$P(S > N) = 1 - P(S = 1) = 1 - 0.2 = 0.8.$$

0.8.

((d) 1)

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