Histograms

98 marks

Hints online, answers free with an account: mathswariz.uk/worksheets/a-level-statistics-histograms/

Date

A Do Now

Quick questions to start. Some use earlier lessons; some set a slip that costs marks.

A1 Needed today [2 marks]

A class $20 < t \leqslant 35$ has frequency 12. Find its frequency density.

Answer .....

A2 Common slip [2 marks]

A bar on a histogram is 5 units wide and has frequency density 3.2. Find the frequency it represents.

Answer .....

A3 Needed today [3 marks]

Estimate the mean of the grouped data in the table.

Value, x	Frequency
$0 < x \leq 10$	4
$10 < x \leq 20$	10
$20 < x \leq 30$	6

Answer .....

A4 Common slip [2 marks]

Ages are recorded in completed years. One class is written 16 to 18. Write down the class width.

Answer .....

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PART 1 Frequency density

EXAMPLE 1 · I DO

The table shows the times, t minutes, of 60 phone calls. Find the frequency density of each class, and say which bar is the tallest.

Time, t (minutes)	Frequency
$0 < t \leq 5$	10
$5 < t \leq 10$	16
$10 < t \leq 20$	20
$20 < t \leq 40$	12
$40 < t \leq 60$	2

Hint Frequency density is frequency divided by class width. The widths here are $5, 5, 10, 20, 20$.

YOUR TURN · WE DO

B1 The table shows the heights, h cm, of 80 seedlings. Find the frequency density of each class, and state which class has the tallest bar on a histogram. [4 marks]

Height, h (cm)	Frequency
$0 < h \leq 4$	12
$4 < h \leq 6$	20
$6 < h \leq 8$	24
$8 < h \leq 12$	16
$12 < h \leq 20$	8

Answer .....

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C1 Sam draws a histogram of the data in the table, using the frequency as the height of each bar. Explain why his histogram is misleading, and find the correct bar heights. [4 marks]

Time, t (s)	Frequency
$0 < t \leq 10$	20
$10 < t \leq 15$	15
$15 < t \leq 30$	30

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C2 The lengths of some fish are measured to the nearest centimetre. Mia works out the frequency densities using class widths $4, 4, 9, 19$. Explain her mistake, and find the correct frequency densities. [4 marks]

Length (cm)	Frequency
10 to 14	15
15 to 19	30
20 to 29	40
30 to 49	20

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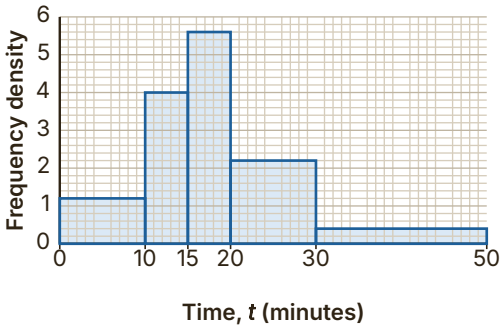
PART 2 Frequencies from a histogram

EXAMPLE 2 · I DO

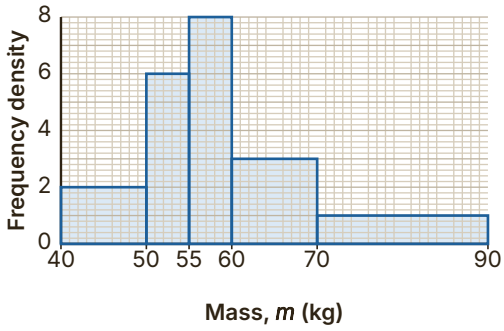
The histogram shows the journey times, t minutes, of some workers. (a) Find the total number of workers. (b) Estimate the number whose journey took between 12 and 25 minutes.



Hint Frequency = frequency density × width. For part of a class, use only the part of the width inside the range.

YOUR TURN · WE DO

B2 The histogram shows the masses, m kg, of some sacks. (a) Find the total number of sacks. (b) Estimate the number with masses between 52 kg and 66 kg. (c) One sack is chosen at random. Estimate the probability that its mass is more than 66 kg. [5 marks]



Answer .....

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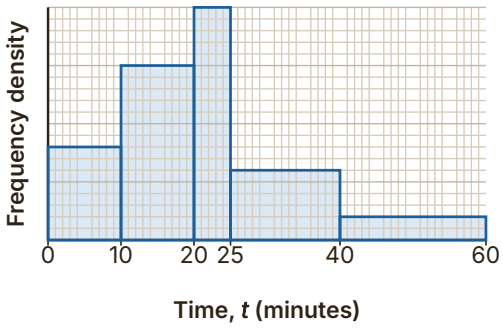
EXAMPLE 3 · I DO

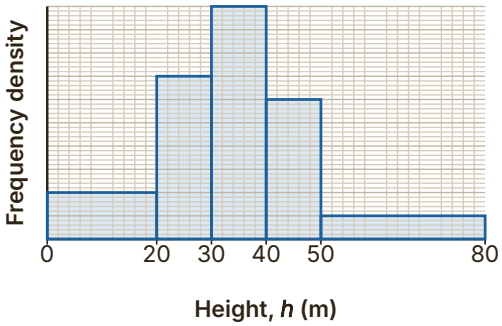
The histogram shows the times, t minutes, that some customers waited. No scale is given. The bar for $10 < t \leqslant 20$ represents 30 customers. Find the total number of customers, and estimate the number who waited between 20 and 30 minutes.



Hint The bar for $10 < t \leqslant 20$ has frequency density $\frac{30}{10} = 3$. Use its height to number the vertical axis.

YOUR TURN · WE DO

B3 The histogram shows the heights, h m, of some trees. No scale is given. The bar for $30 < h \leqslant 40$ represents 50 trees. Find the total number of trees, and estimate the number between 22 m and 45 m tall. [5 marks]



Answer .....

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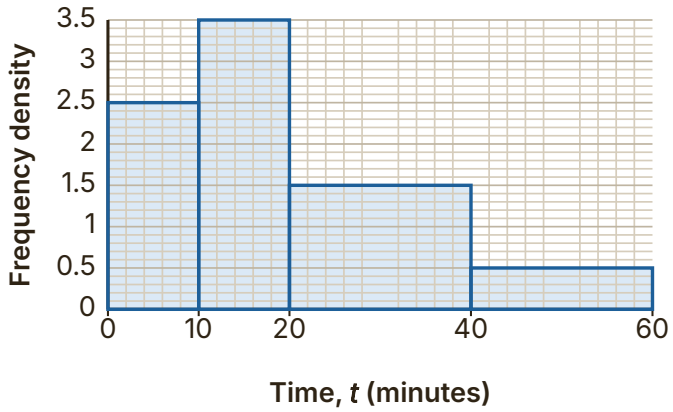
C3 The histogram shows the times, t minutes, that 100 visitors spent in a museum shop. Ria says "1.5 visitors spent between 20 and 40 minutes", reading the height of the bar. Explain her mistake, and estimate the percentage of visitors who spent more than 30 minutes. [5 marks]



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C4 The table shows the times, t minutes, that 90 patients waited at a clinic.

Time, t (minutes)	Frequency
$0 < t \leq 10$	12
$10 < t \leq 15$	20
$15 < t \leq 25$	f
$25 < t \leq 40$	18

(a) Find f, and the frequency density of each class. [3 marks]

Answer .....

(b) Estimate the number of patients who waited between 12 and 30 minutes. [3 marks]

Answer .....

Total for C4: 6 marks

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PART 3 Bar widths and heights in centimetres

EXAMPLE 4 · I DO

On a histogram, the class $10 < t \leqslant 15$, with frequency 30, is drawn as a bar 2 cm wide and 6 cm tall. The class $15 < t \leqslant 25$ has frequency 18. Find the width and the height of its bar.

Hint Widths: 5 units is 2 cm. Areas: 30 people is $2 \times 6 = 12$ cm².

YOUR TURN · WE DO

B4 On a histogram, the class $20 < x \leqslant 30$, with frequency 45, is drawn as a bar 1.5 cm wide and 9 cm tall. The class $30 < x \leqslant 50$ has frequency 24. Find the width and the height of its bar. [4 marks]

Answer .....

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C5 On a histogram, the bar for $0 < x \leqslant 5$ has frequency 12 and is drawn 1 cm wide and 4.8 cm tall. Another bar is 2 cm wide and 3.6 cm tall. Find the width of its class and its frequency. [4 marks]

Answer .....

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C6 On a histogram, the class $4 < t \leqslant 6$, with frequency 18, is drawn as a bar 1 cm wide and 9 cm tall. The class $6 < t \leqslant 12$ has frequency 27, and the class $0 < t \leqslant 4$ has frequency 8. Find the width and the height of the bars for these two classes. [7 marks]

Answer .....

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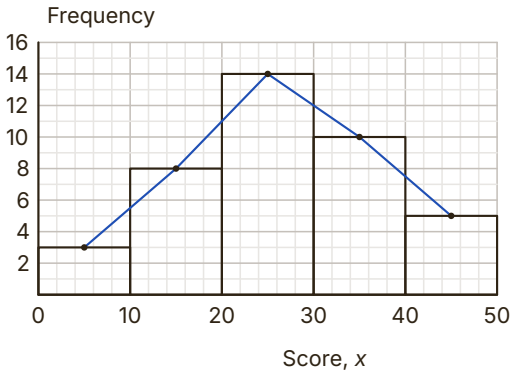
PART 4 Frequency polygons

EXAMPLE 5 · I DO

The histogram shows the test scores, x, of 40 students. The classes are all 10 wide, so the heights are frequencies. A frequency polygon is drawn on it in blue. Give the points of the polygon and estimate the mean score.



Hint A frequency polygon joins the tops of the bars at the class MIDPOINTS $5, 15, 25, 35, 45$ with straight lines.

YOUR TURN · WE DO

B5 The table shows the ages, a years, of 50 singers in a choir. List the points of a frequency polygon, state the modal class, and estimate the mean age. [4 marks]

Age, a (years)	Frequency
$10 < a \leq 20$	6
$20 < a \leq 30$	12
$30 < a \leq 40$	18
$40 < a \leq 50$	9
$50 < a \leq 60$	5

Answer .....

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C7 Leo draws a frequency polygon for the data in the table by plotting $(20, 8)$, $(40, 14)$, $(60, 10)$ and $(80, 4)$. Explain his mistake, give the correct points, and estimate the mean. [4 marks]

Distance, d (km)	Frequency
$0 < d \leq 20$	8
$20 < d \leq 40$	14
$40 < d \leq 60$	10
$60 < d \leq 80$	4

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C8 The table shows the lengths, l mm, of 60 leaves. The classes have different widths. List the points of a frequency polygon drawn on a histogram of these data, and estimate the mean length. [4 marks]

Length, l (mm)	Frequency
$0 < l \leq 20$	12
$20 < l \leq 30$	18
$30 < l \leq 40$	21
$40 < l \leq 60$	9

Answer .....

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D1 The times, t minutes, that 100 students took to finish a puzzle are summarised in the table.

Time, t (minutes)	Frequency
$0 < t \leq 10$	10
$10 < t \leq 15$	20
$15 < t \leq 20$	35
$20 < t \leq 30$	25
$30 < t \leq 50$	10

(a) Find the frequency density of each class. [2 marks]

Answer .....

(b) Use linear interpolation to estimate the median. [3 marks]

Answer .....

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(c) Estimate the mean and the standard deviation. [4 marks]

Answer .....

(d) Estimate the number of students who took between 12 and 26 minutes. [2 marks]

Answer .....

Total for D1: 11 marks

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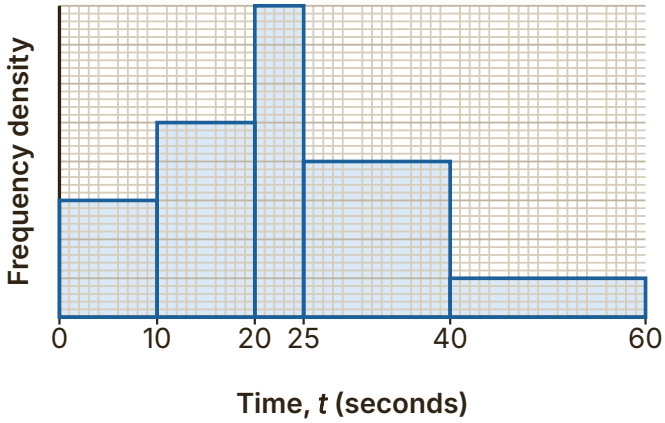
D2

The histogram shows the times, t seconds, of some runners in a sprint. No scale is given. The bar for $10 < t \leqslant 20$ represents 25 runners. Jamal says: "The bar for $20 < t \leqslant 25$ is the tallest, so that class has the most runners."

Jamal is wrong.

(a) Find the frequency of each class. [4 marks]



Answer .....

(b) Explain why Jamal is wrong. [2 marks]

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(c) Estimate the number of runners with times more than 30 seconds. [3 marks]

Answer .....

Total for D2: 9 marks

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E Extension

Stretch

No route is given. The hints are at the end of the sheet. Use one at a time.

E1 The table shows the distances, x km, travelled by 100 delivery vans in a day. On a histogram, the bar for $10 < x \leqslant 15$ is 4 times as tall as the bar for $0 < x \leqslant 10$. The bar for $25 < x \leqslant 45$ is drawn 1.2 cm tall. Find a and b, the height of the bar for $15 < x \leqslant 25$, and an estimate of the median distance. [9 marks]

Distance, x (km)	Frequency
$0 < x \leq 10$	a
$10 < x \leq 15$	30
$15 < x \leq 25$	b
$25 < x \leq 45$	12

Answer .....

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Extension hints

Cover these with paper. Uncover one at a time.

E1

Hint 1 The height of a bar is its frequency density. Write the densities of the first two classes as $\frac{a}{10}$ and $\frac{30}{5}$.

Hint 2 $6 = 4 \times \frac{a}{10}$ gives a. Then b comes from the total of 100.

Hint 3 The bar for $25 < x \leqslant 45$ has density 0.6 and is 1.2 cm tall, so 1 unit of density is 2 cm. For the median, the 50th value is in $15 < x \leqslant 25$.

How did it go?

Colour one circle on each line: not yet, nearly, yes.

I can work out frequency densities and draw a histogram for classes of unequal width.	○ ○ ○
I can find frequencies from a histogram, including when no scale is given and one bar's frequency is known.	○ ○ ○
I can find the width and height of a bar from the size of another bar.	○ ○ ○
I can draw a frequency polygon and estimate the mean, standard deviation and median from a histogram.	○ ○ ○

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