
S1 Chapter 3: Data Representations

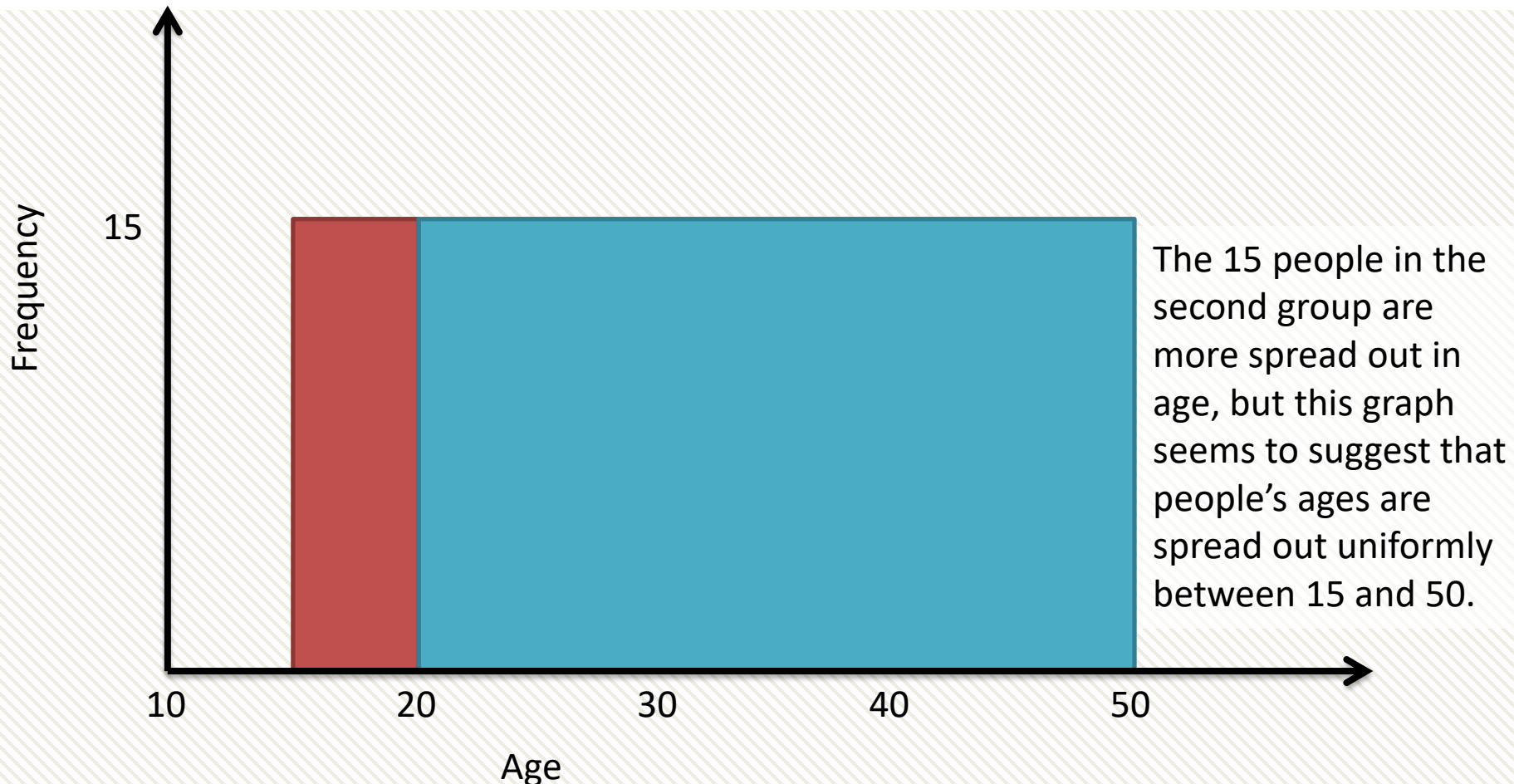
Histograms

Histograms

Age (years)	Frequency
$15 \leq a < 20$	15
$20 \leq a < 50$	15

Pablo is hosting a party. He counts how many people are between 15 and 20, and 20 and 50.

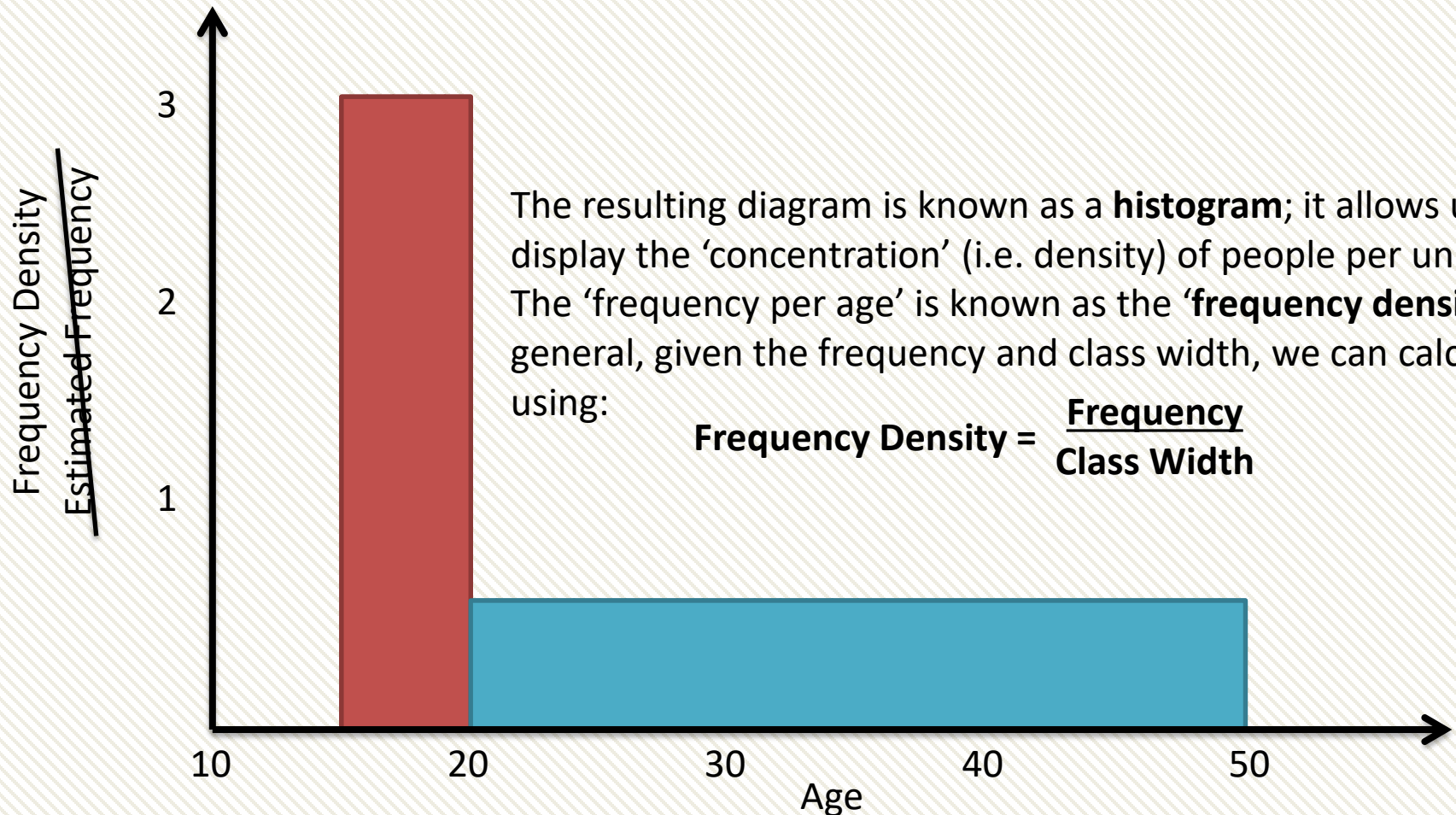
Why is below graph somewhat unhelpful.
How could we fix it?



Age (years)	Frequency
$15 \leq a < 20$	15
$20 \leq a < 50$	15

Let's presume that within each age group, the ages are evenly spread.

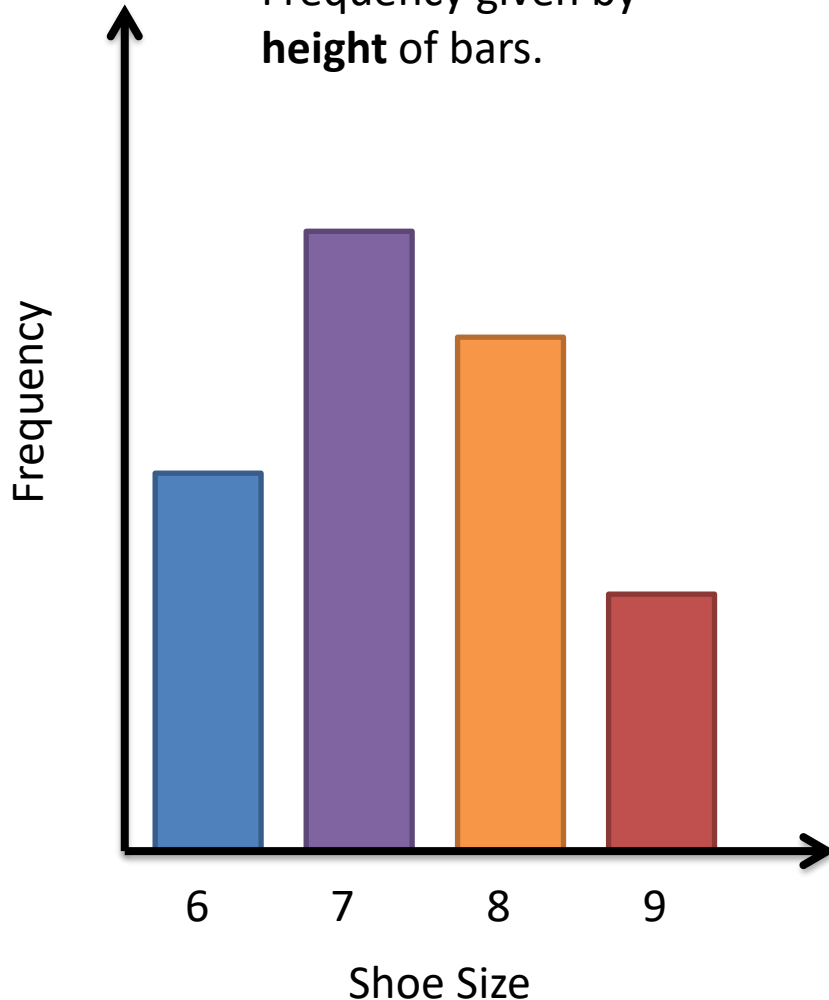
Then there would **3** people of each age in the 15-20 group, and **0.5** people of each age in the 20-50 group.



Bar Charts vs Histograms

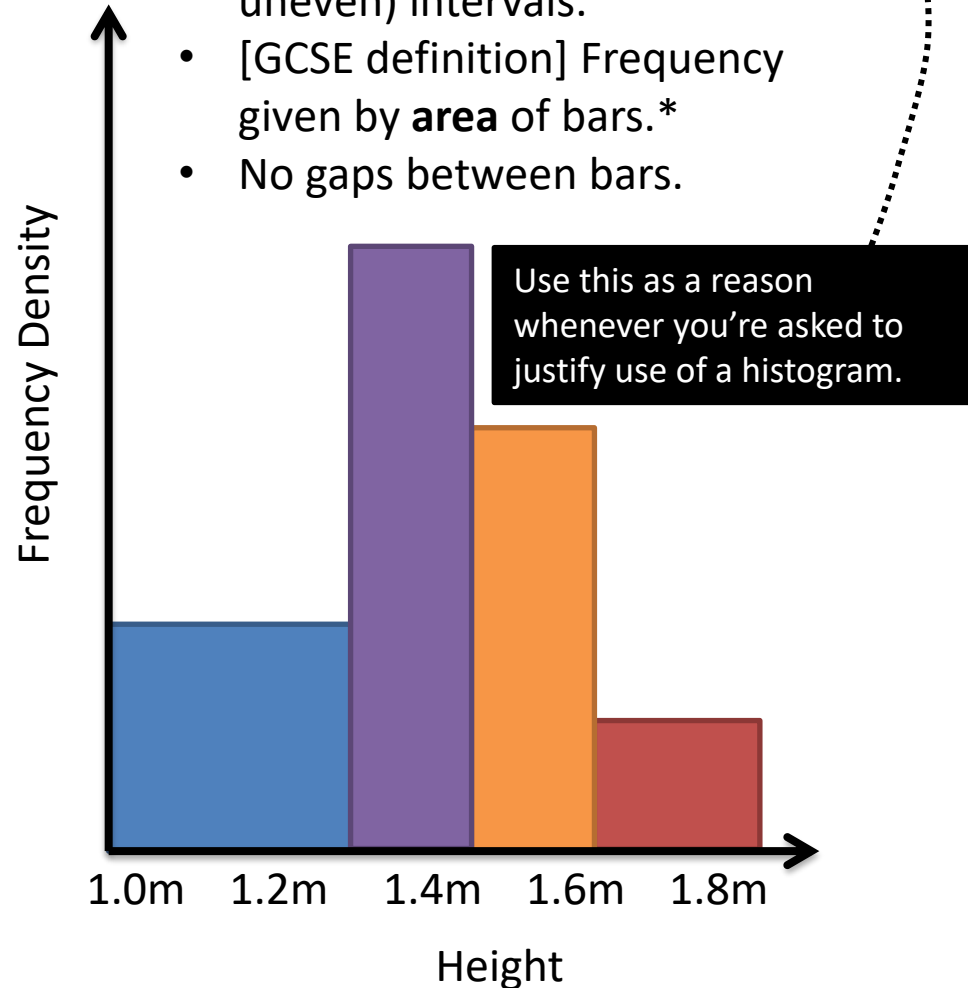
Bar Charts

- For **discrete** data.
- Frequency given by **height** of bars.



Histograms

- For **continuous** data.
- Data divided into (potentially uneven) intervals.
- [GCSE definition] Frequency given by **area** of bars.*
- No gaps between bars.



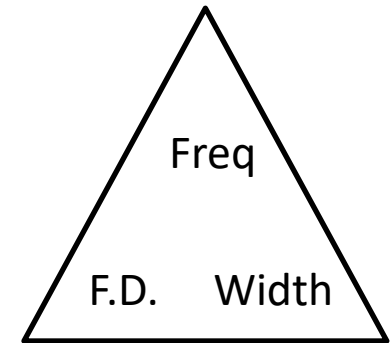
* Not necessarily true. We'll correct this in a sec.

Bar Charts vs Histograms

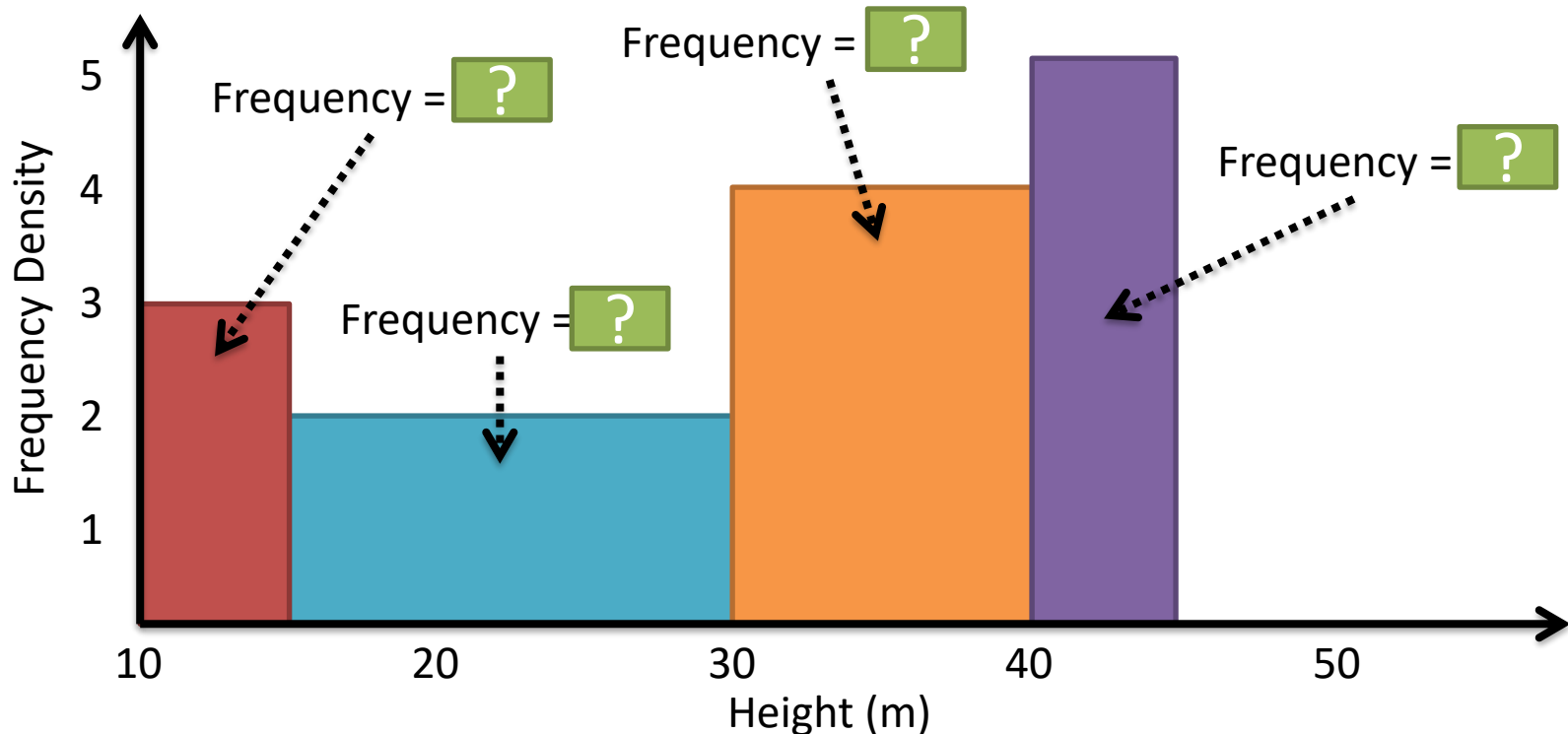
Q1

Weight (w kg)	Frequency	Frequency Density
$0 < w \leq 10$	40	?
$10 < w \leq 15$	6	?
$15 < w \leq 35$?	2.6
$35 < w \leq 45$?	1

Still using the incorrect GCSE formula:



Q2

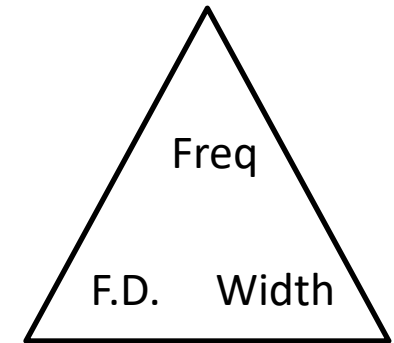


Bar Charts vs Histograms

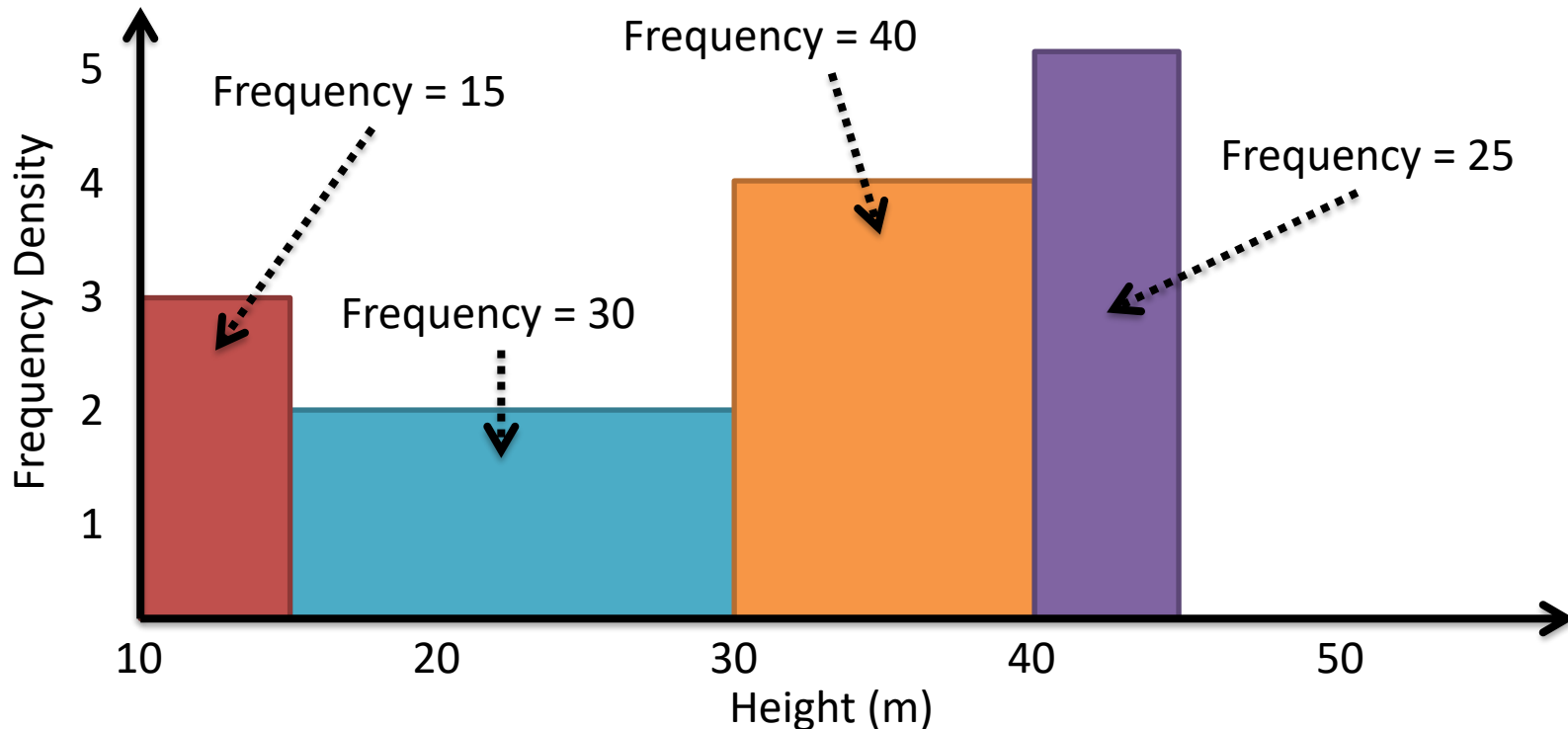
Q1

Weight (w kg)	Frequency	Frequency Density
$0 < w \leq 10$	40	4
$10 < w \leq 15$	6	1.2
$15 < w \leq 35$	52	2.6
$35 < w \leq 45$	10	1

Still using the incorrect GCSE formula:




Q2

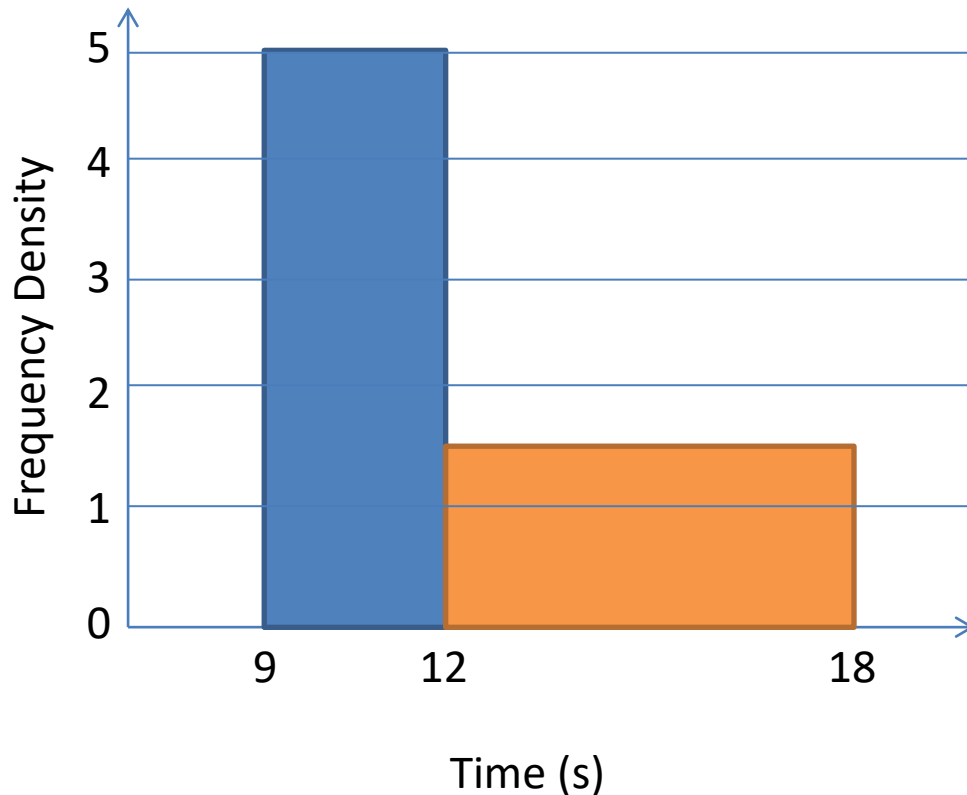


SKILL #1 :: Area = frequency?

Unlike at GCSE, the area of a bar is not necessarily equal to the frequency; there are just **proportional**.

 Identify the scaling $\text{area} \xrightarrow{\times k} \text{frequency}$ using a known area with known frequency (which may be total area/frequency or just one bar)

There were 60 runners in a 100m race. The following histogram represents their times. Determine the number of runners with times above 14s.



Total frequency is known; therefore find total area and hence the 'scaling'.

$$\text{Total area} = 15 + 9 = 24$$

Area	Freq
24	$\xrightarrow{\times k} 60$
$k = \frac{60}{24} = 2.5$	

Then use this scaling along with the desired area.

$$\text{Area} = 4 \times 1.5 = 6$$

$$\text{Frequency} = 6 \times 2.5 = 15$$

Test Your Understanding

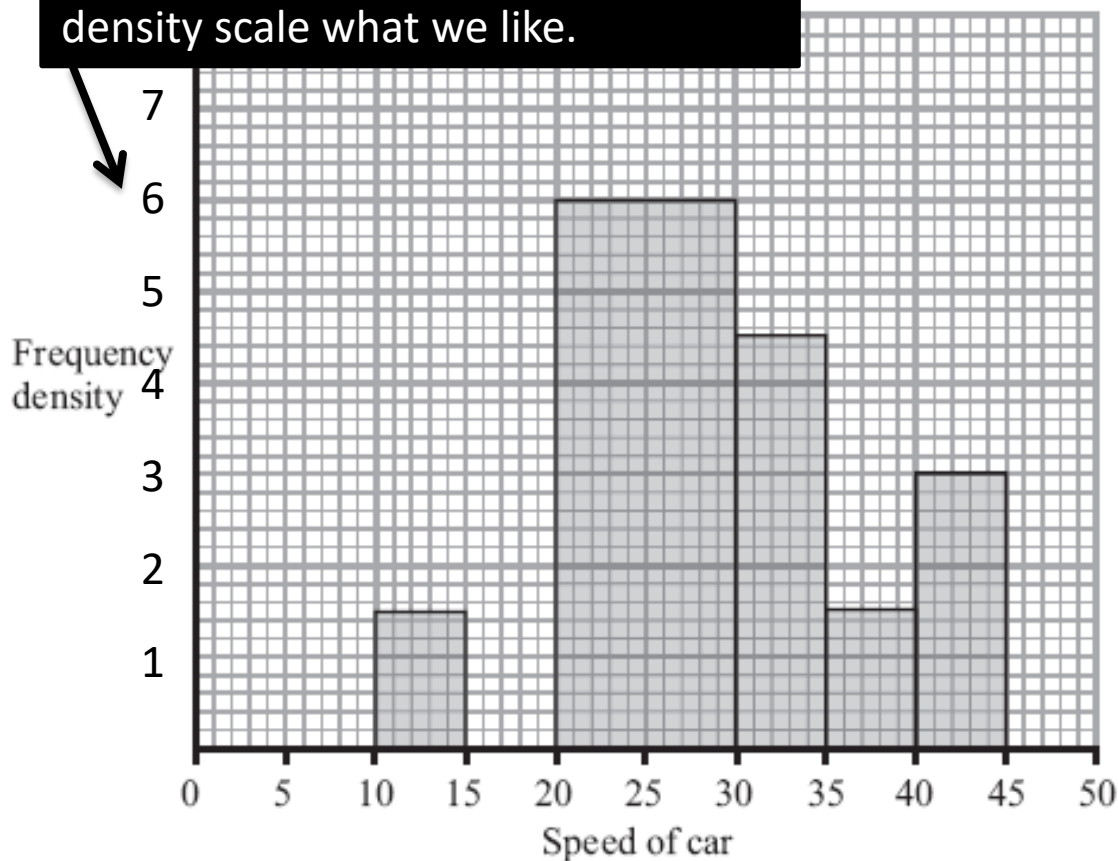
(on your printed sheet)

Edexcel S1 May 2012 Q5

A policeman records the speed of the traffic on a busy road with a 30 mph speed limit. He records the speeds of a sample of 450 cars. The histogram in Figure 2 represents the results.

(a) Calculate the number of cars that were exceeding the speed limit by at least 5 mph in the sample. (4 marks)

Fro Tip: We can make the frequency density scale what we like.



M1 A1: Determine what one small square or one large square is worth.

(i.e. work out *area* → *freq* scaling)

?

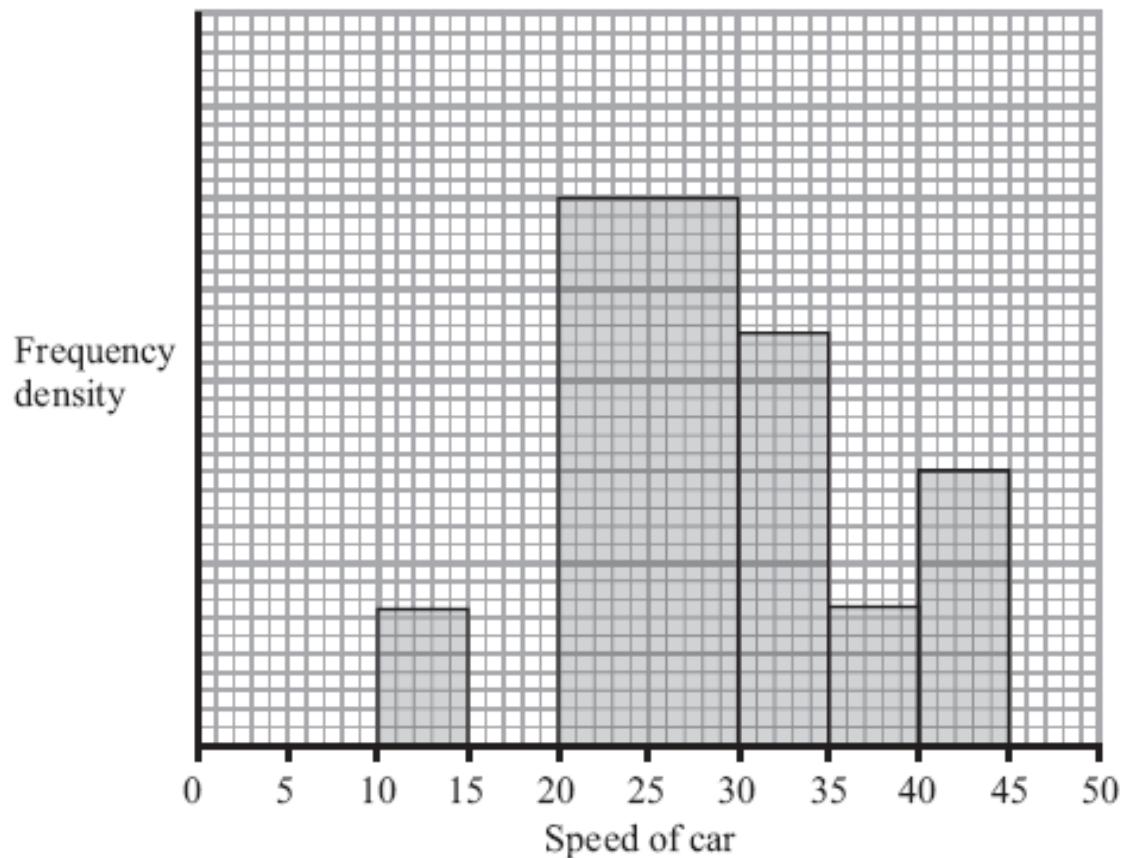
M1 A1: Use this to find number of cars travelling >35mph.

?

Test Your Understanding

(on your printed sheet)

(b) Estimate the value of the mean speed of the cars in the sample. (3 marks)



M1 M1: Use histogram to construct sum of speeds.

?

A1 Correct value

?

Fro Tip: Whenever you are asked to calculate mean, median or quartiles from a histogram, form a grouped frequency table. Use your scaling factor to work out the frequency of each bar.

Test Your Understanding

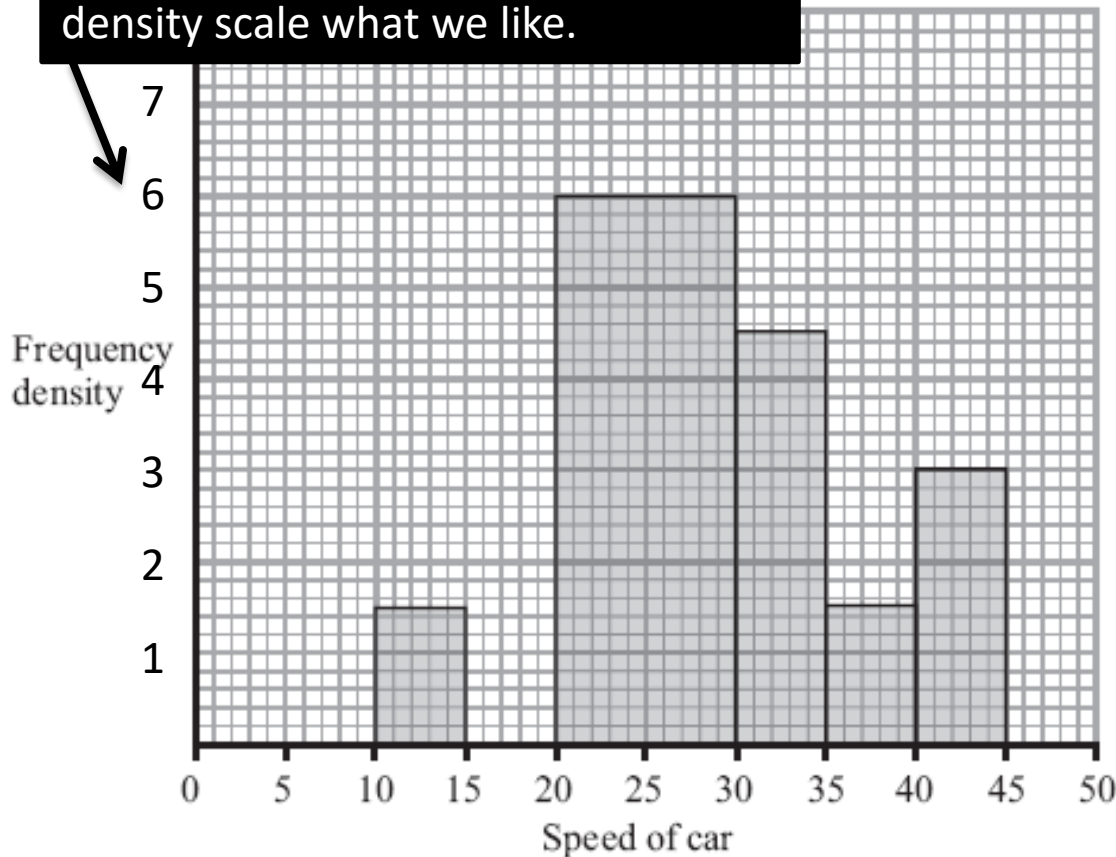
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Edexcel S1 May 2012 Q5

A policeman records the speed of the traffic on a busy road with a 30 mph speed limit. He records the speeds of a sample of 450 cars. The histogram in Figure 2 represents the results.

(a) Calculate the number of cars that were exceeding the speed limit by at least 5 mph in the sample. (4 marks)

Fro Tip: We can make the frequency density scale what we like.



M1 A1: Determine what one small square or one large square is worth.

(i.e. work out *area* \rightarrow *freq* scaling)

Area	Freq
112.5	$\xrightarrow{\times k}$ 450

$$k = \frac{450}{112.5} = 4$$

M1 A1: Use this to find number of cars travelling >35 mph.

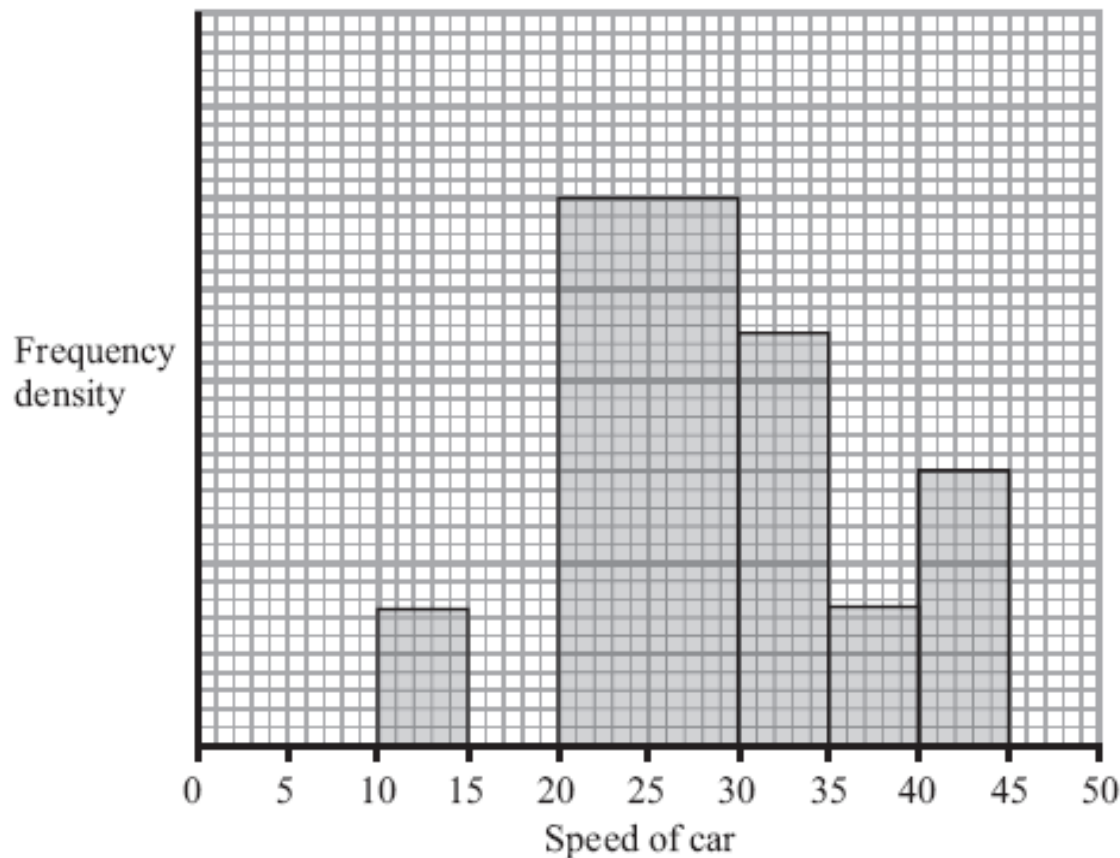
Area	Freq
22.5	$\xrightarrow{\times 4}$ 90

Write: $22.5 \times 4 = 90$

Test Your Understanding

(on your printed sheet)

(b) Estimate the value of the mean speed of the cars in the sample. (3 marks)



M1 M1: Use histogram to construct sum of speeds.

$$\frac{30 \times 12.5 + 240 \times 25 + \dots}{450}$$

A1 Correct value

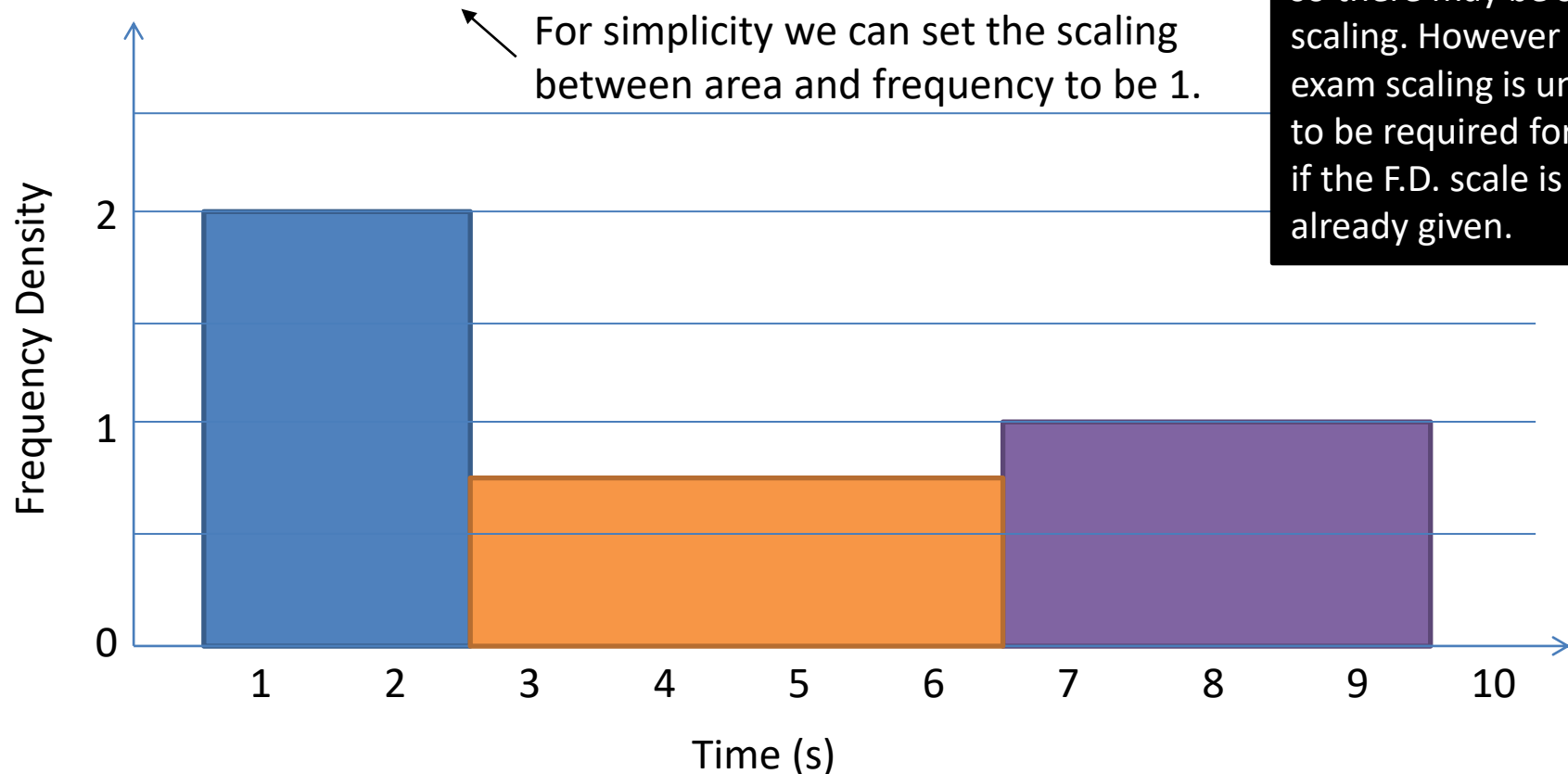
$$= 28.8$$

Fro Tip: Whenever you are asked to calculate mean, median or quartiles from a histogram, form a grouped frequency table. Use your scaling factor to work out the frequency of each bar.

SKILL #2 :: Gaps!

Weight (to nearest kg)	Frequency	F.D.
1-2	4	$4 \div 2 = 2$
3-6	3	$3 \div 4 = 0.75$
7-9	$3 \times 1 = 3$	1

Note the gaps
affects class width!
Remember the frequency density axis is only correct to scale, so there may be some scaling. However in an exam scaling is unlikely to be required for F.D. if the F.D. scale is already given.

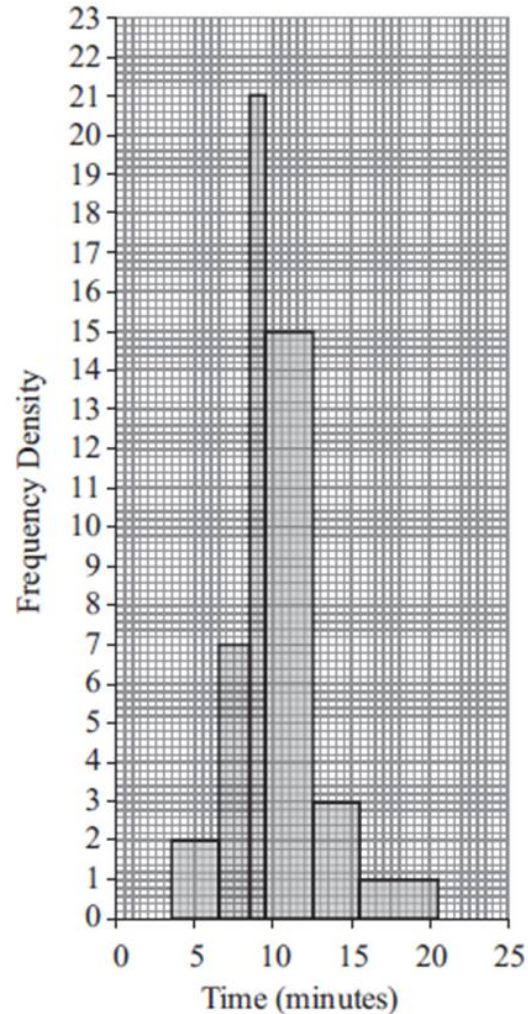


Test Your Understanding

(on your printed sheet)

Jan 2012 Q1

The histogram in Figure 1 shows the time, to the nearest minute, that a random sample of 100 motorists were delayed by roadworks on a stretch of motorway.



Fro Tip: Be careful that you use the correct class widths!

(a) Complete the table.

Delay (minutes)	Number of motorists
4 – 6	6
7 – 8	?
9	21
10 – 12	45
13 – 15	9
16 – 20	?

(2)

(b) Estimate the number of motorists who were delayed between 8.5 and 13.5 minutes by the roadworks.

(2)

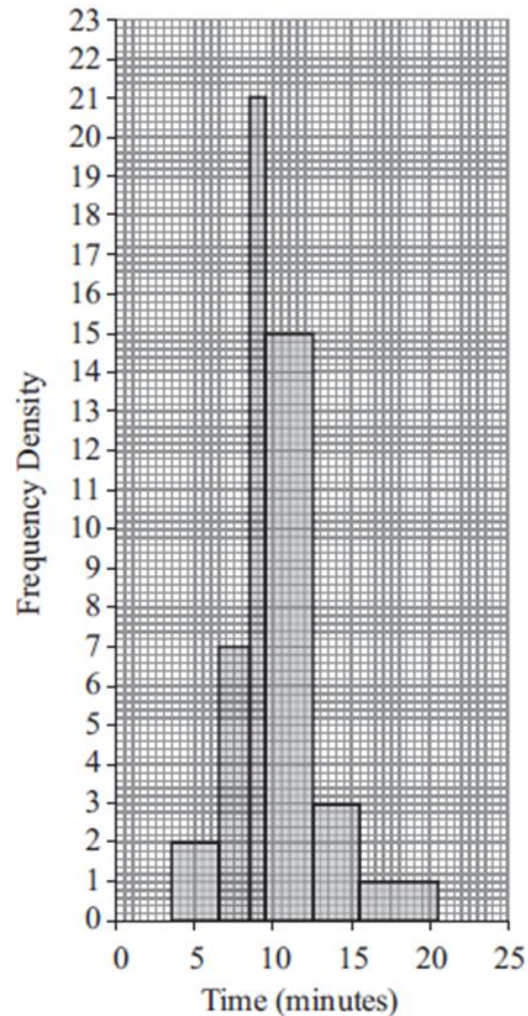
?

Test Your Understanding

(on your printed sheet)

Jan 2012 Q1

The histogram in Figure 1 shows the time, to the nearest minute, that a random sample of 100 motorists were delayed by roadworks on a stretch of motorway.



Fro Tip: Be careful that you use the correct class widths!

(a) Complete the table.

Delay (minutes)	Number of motorists
4 – 6	6
7 – 8	?
9	21
10 – 12	45
13 – 15	9
16 – 20	5

(2)

(b) Estimate the number of motorists who were delayed between 8.5 and 13.5 minutes by the roadworks.

(2)


$$21 + 45 + 3 = 69$$

SKILL #3 :: Width and height on diagram

An exam favourite is to ask what width and height we'd draw a bar in a drawn histogram.

Q: The frequency table shows some running times. On a histogram the bar for 0-4 seconds is drawn with width 6cm and height 8cm. Find the width and height of the bar for 4-6 seconds.

Time (seconds)	Frequency
$0 \leq t < 4$	8
$4 \leq t < 6$	9

 **Tip:** Find the scaling for class width to drawn width and frequency density to drawn height.

For 0-4 bar:

Class width = 4

Frequency density = $8 \div 4 = 2$

\therefore Scaling for width: 1.5

Scaling for height: 4

4-6 bar: class width 2, frequency density 4.5

Width = $2 \times 1.5 = 3cm$

Height = $4.5 \times 4 = 18cm$

Test Your Understanding

(on your printed sheet)

[May 2009 Q3] The variable x was measured to the nearest whole number. Forty observations are given in the table below.

x	10 – 15	16 – 18	19 –
Frequency	15	9	16

A histogram was drawn and the bar representing the 10 – 15 class has a width of 2 cm and a height of 5 cm. For the 16 – 18 class find

- (a) the width, (1)
 - (b) the height (2)
- of the bar representing this class.

(a)

?

B1

(b)

?

M1

M1

A1

Test Your Understanding

(on your printed sheet)

[May 2009 Q3] The variable x was measured to the nearest whole number. Forty observations are given in the table below.

x	10 – 15	16 – 18	19 –
Frequency	15	9	16

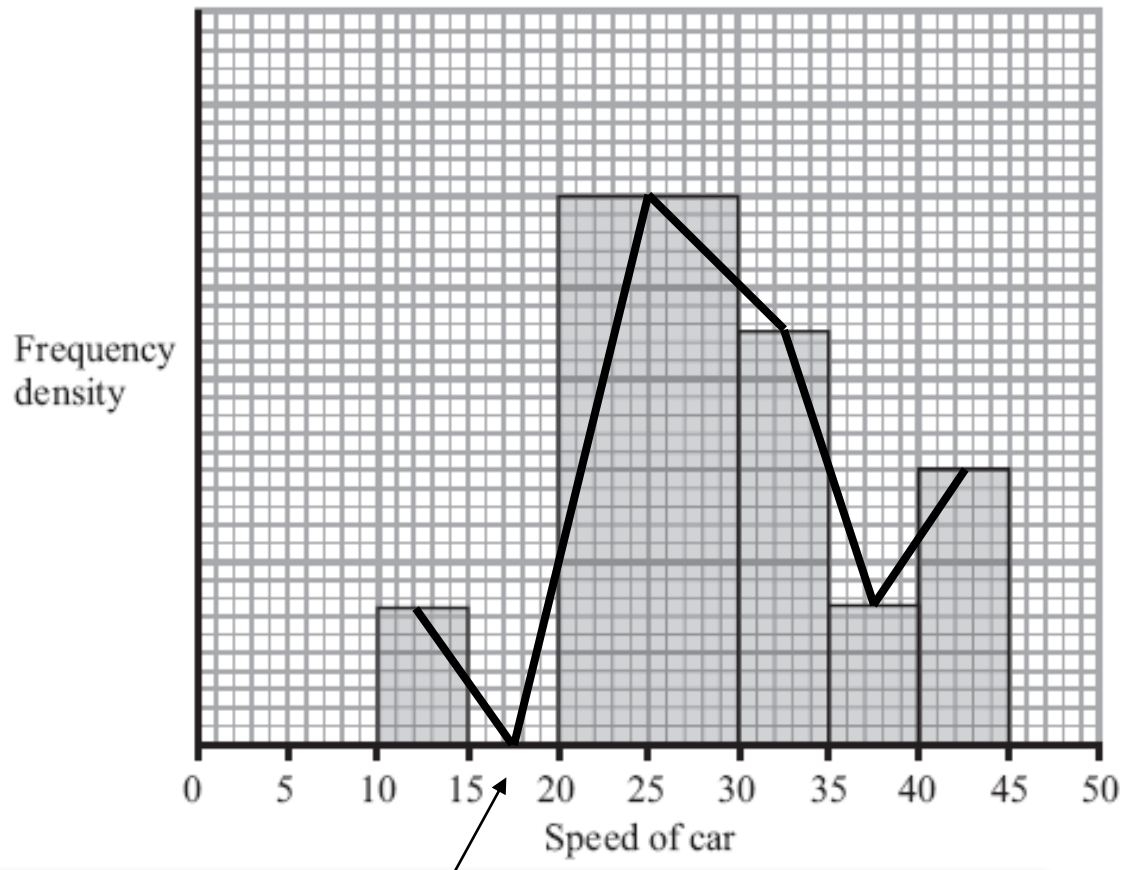
A histogram was drawn and the bar representing the 10 – 15 class has a width of 2 cm and a height of 5 cm. For the 16 – 18 class find

- (a) the width, (1)
 (b) the height (2)
 of the bar representing this class.

(a)	1(cm)	cao	B1
(b)	10 cm ² represents 15 10/15 cm ² represents 1	or 1 cm ² represents 1.5	M1
	Therefore frequency of 9 is $\frac{10}{15} \times 9$ or $\frac{9}{1.5}$	Require $\times \frac{2}{3}$ or $\div 1.5$	M1
	height = 6 (cm)		A1

SKILL #4 :: Forming a frequency polygon

Recall that a frequency polygon can be drawn by using the midpoint of each interval. This corresponds to the midpoint of the top of each bar in a histogram.



[Click to Sketch](#)

Note that the frequency in this interval is 0. That needs to be reflected in the frequency polygon.

Exercise 3.4

Pearson Pure Mathematics Year 1/AS

Pages 20-22

Homework Exercise

- 1 The data shows the mass, in pounds, of 50 adult puffer fish.

- a Draw a histogram for this data.
- b On the same set of axes, draw a frequency polygon.

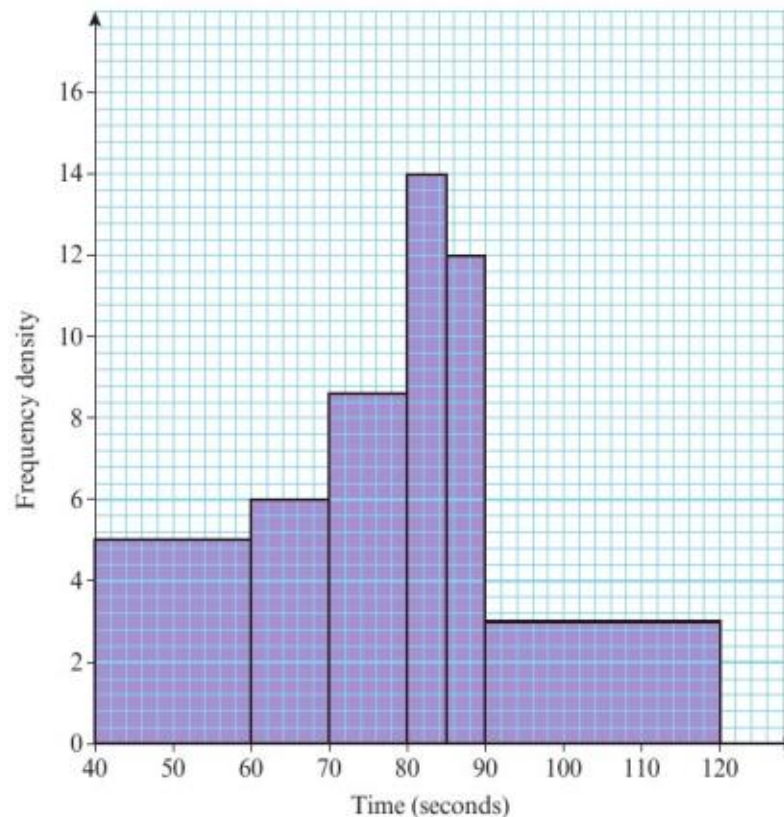
Mass, m (pounds)	Frequency
$10 \leq m < 15$	4
$15 \leq m < 20$	12
$20 \leq m < 25$	23
$25 \leq m < 30$	8
$30 \leq m < 35$	3

- 2 Some students take part in an obstacle race. The time it took each student to complete the race was noted. The results are shown in the histogram.

- a Give a reason to justify the use of a histogram to represent this data.

The number of students who took between 60 and 70 seconds is 90.

- b Find the number of students who took between 40 and 60 seconds.
- c Find the number of students who took 80 seconds or less.
- d Calculate the total number of students who took part in the race.

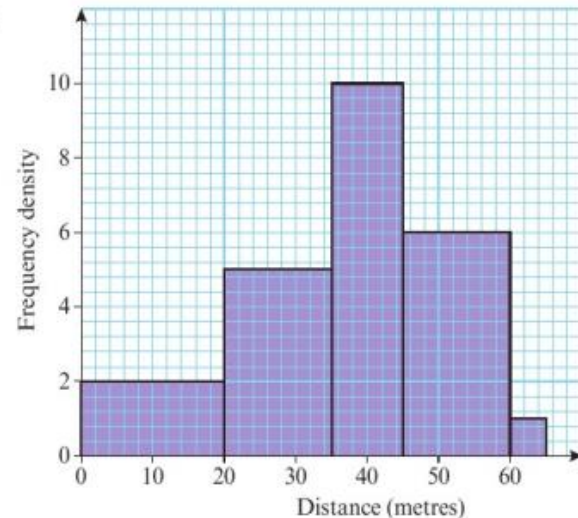


Watch out Frequency density \times class width is always **proportional** to frequency in a histogram, but not necessarily **equal** to frequency.

Homework Exercise

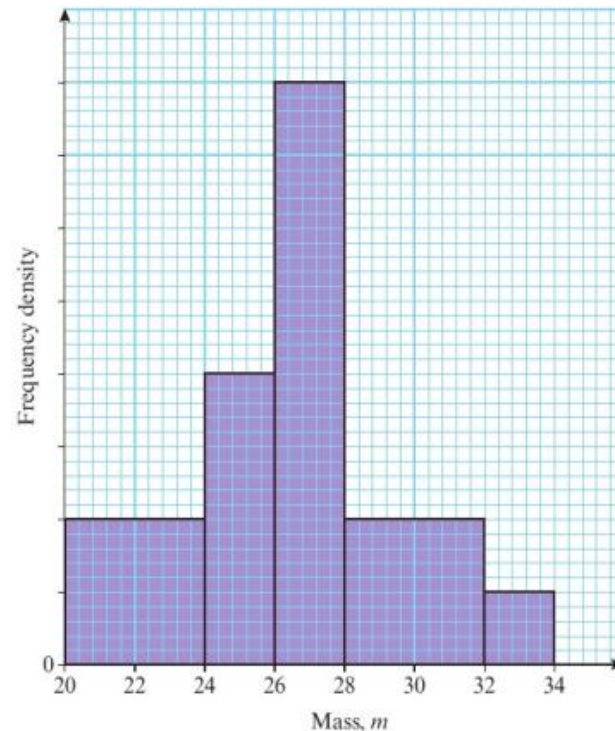
- 3 A Fun Day committee at a local sports centre organised a throwing the cricket ball competition. The distance thrown by every competitor was recorded. The histogram shows the data. The number of competitors who threw less than 20 m was 40.

- a Why is a histogram a suitable diagram to represent this data?
- b How many people entered the competition?
- c Estimate how many people threw between 30 and 40 metres.
- d How many people threw between 45 and 65 metres?
- e Estimate how many people threw less than 25 metres.



- 4 A farmer found the masses of a random sample of lambs. The masses were summarised in a grouped frequency table and represented by a histogram. The frequency for the class $28 \leq m < 32$ was 32.

- a Show that 25 small squares on the histogram represents 8 lambs.
- b Find the frequency of the $24 \leq m < 26$ class.
- c How many lambs did the farmer weigh in total?
- d Estimate the number of lambs that had masses between 25 and 29 kg.

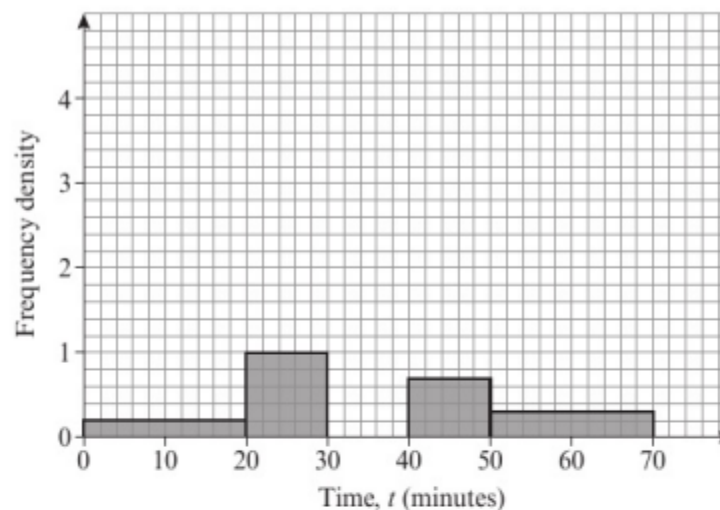


Homework Exercise

- 5 The partially completed histogram shows the time, in minutes, that passengers were delayed at an airport.

a i Copy and complete the table.

Time, t (min)	Frequency
$0 \leq t < 20$	4
$20 \leq t < 30$	
$30 \leq t < 35$	15
$35 \leq t < 40$	25
$40 \leq t < 50$	
$50 \leq t < 70$	



ii Copy and complete the histogram.

(4 marks)

b Estimate the number of passengers that were delayed for between 25 and 38 minutes. (2 marks)

- 6 The variable y was measured to the nearest whole number. 60 observations were taken and are recorded in the table below.

y	10–12	13–14	15–17	18–25
Frequency	6	24	18	12

a Write down the class boundaries for the 13–14 class.

(1 mark)

A histogram was drawn and the bar representing the 13–14 class had a width of 4 cm and a height of 6 cm.

For the bar representing the 15–17 class, find:

b i the width

(1 mark)

ii the height.

(2 marks)

Problem-solving

Remember that area is proportional to frequency.

Homework Exercise

- 7 From the large data set, the daily mean temperature for Leeming during May 2015 is summarised in the table. A histogram was drawn. The $8 \leq t < 10$ group was represented by a bar of width 1 cm and a height of 8 cm.

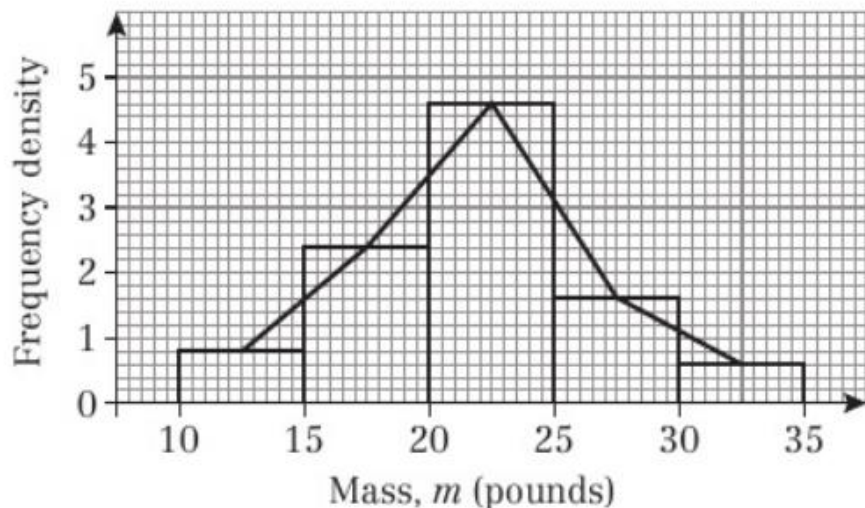
- a Find the width and height of the bar representing the $11 \leq t < 12$ group. **(2 marks)**
- b Use your calculator to estimate the mean and standard deviation of temperatures in Leeming in May 2015. **(3 marks)**
- c Use linear interpolation to find an estimate for the lower quartile of temperatures. **(2 marks)**
- d Estimate the number of days in May 2015 on which the temperature was higher than the mean plus one standard deviation. **(2 marks)**

Daily mean temperature, t ($^{\circ}\text{C}$)	Frequency
$4 \leq t < 8$	4
$8 \leq t < 10$	8
$10 \leq t < 11$	6
$11 \leq t < 12$	7
$12 \leq t < 15$	5
$15 \leq t < 16$	1

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Homework Answers

1



2 a The quantity (time) is continuous.

b 150 c 369 d 699

3 a The quantity (distance) is continuous.

b 310 c 75 d 95 e 65

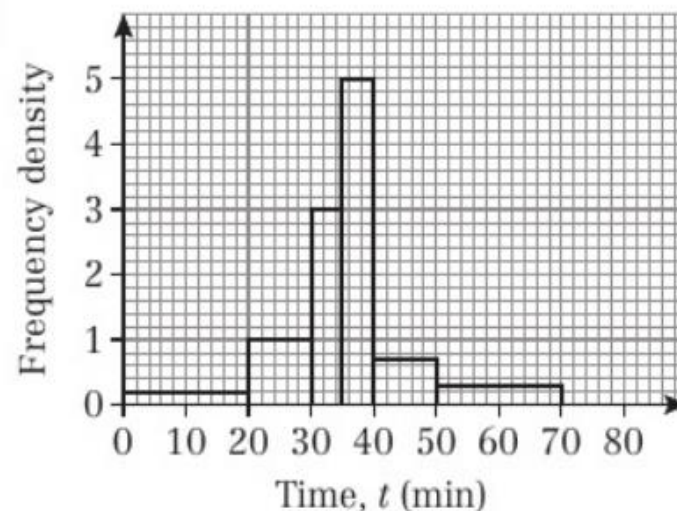
4 a 32 lambs is represented by 100 small squares, therefore 25 small squares represents 8 lambs.

b 32 c 168 d 88

5 a i

Time, t (min)	Frequency
$0 \leq t < 20$	4
$20 \leq t < 30$	10
$30 \leq t < 35$	15
$35 \leq t < 40$	25
$40 \leq t < 50$	7
$50 \leq t < 70$	6

ii



b 35

6 a 12.5 and 14.5

b i 6 cm ii 3 cm

7 a Width 0.5 cm, height 14 cm

b Mean 10.4, standard deviation 2.4

c 9°C d 4.7 days