

Mathematics and Numeracy

Histograms

Check that you can:

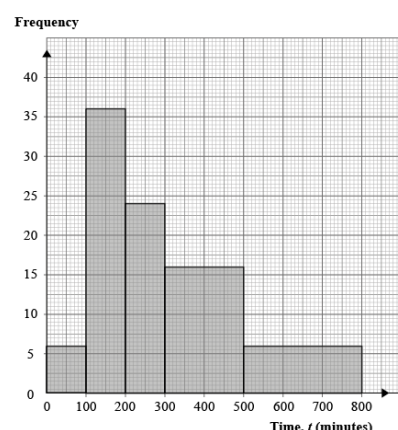
- calculate areas of squares and rectangles
- find the missing length or width of a square or rectangle, given the area and either a length or width
- group data into a grouped frequency table
- transfer data into a graph format, selecting appropriate scales for the axes.

Histograms

The number of minutes a group of people spent watching a certain television channel on a particular day is shown on the frequency table below.

Time, t (minutes)	Frequency
$0 \leq t < 100$	6
$100 \leq t < 200$	36
$200 \leq t < 300$	24
$300 \leq t < 500$	16
$500 \leq t < 800$	6

An **incorrect** frequency diagram which attempts to represent this information is shown below:



Notice that the class intervals are not equal. The first three class intervals have a class width of 100 minutes. $300 \leq t < 500$ has a class width of 200 minutes. $500 \leq t < 800$ has a class width of 300 minutes. Because the class intervals are unequal, the frequency diagram seen above does not represent the data fairly. Look at the size of

the bars for $0 \leq t < 100$ and $500 \leq t < 800$, where both have a frequency of six. This implies that there are six people in each of the groups $500 \leq t < 600$, $600 \leq t < 700$ and $700 \leq t < 800$ which is clearly incorrect.

Instead of a frequency diagram, a **histogram** is used when the class intervals are of unequal width.

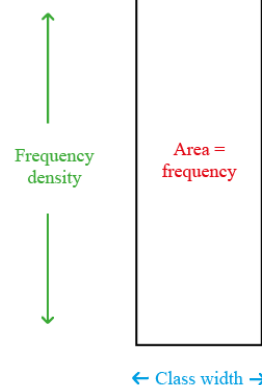
In a histogram, the **area of the bars represents the frequency**.

By multiplying the width and the height of the bar together, we get the frequency of that class interval.

The width of the bar is represented by the class, or interval width.

The height of the bar is called **frequency density**.

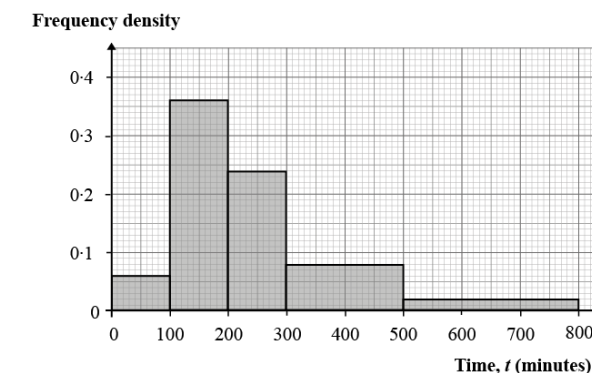
To find the frequency density of a class interval, we divide the area (frequency) by the class width.



The class width of the first class interval = $100 - 0 = 100$
 The frequency density of the first class interval = $6 \div 100$
 = 0.06

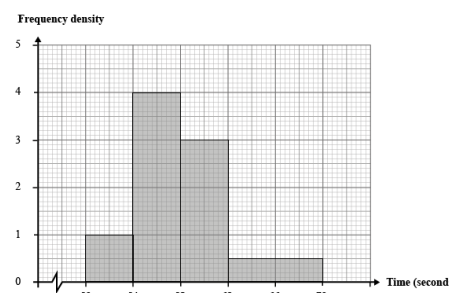
Time, t (minutes)	Frequency	Class width	Frequency density = frequency $\div$ class width
$0 < t \leq 100$	6	100	0.06
$100 < t \leq 200$	36	100	0.36
$200 < t \leq 300$	24	100	0.24
$300 < t \leq 500$	16	200	0.08
$500 < t \leq 800$	6	300	0.02

We can use this information to draw a histogram. The frequency density will always be on the vertical axis. Here you can see the completed histogram.



Example

The time taken to run a distance of 400m was recorded for each member of a running club. The histogram below shows the results for the members who are under 30 years of age.



To calculate how many members of the running club are under 30 years of age, we need to look at the areas of the bars.

The area of each bar gives the frequency. To find the total frequency, find the area of each bar and add them together.

Remember:

Frequency = class width $\times$ frequency density

$$4 \times 1 = 4$$

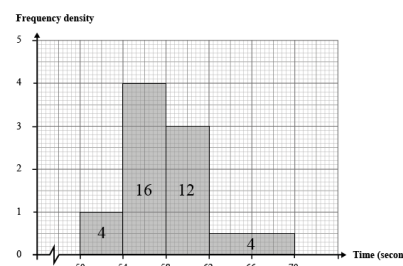
$$4 \times 4 = 16$$

$$4 \times 3 = 12$$

$$8 \times 0.5 = 4$$

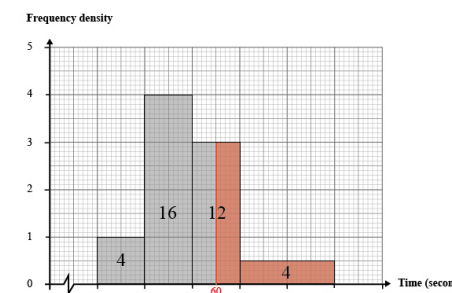
$$4 + 16 + 12 + 4 =$$

$$36 \text{ members}$$



These frequencies can be written in the bars for use later.

To calculate (to the nearest whole number) an estimate of the percentage of members that took more than one minute to run 400m, we need to find the area of the bars shaded red in the diagram below.



As the frequencies have already been written on the bars, the answer is $12 \div 2 + 4 = 10$.

This can also be calculated using $2 \times 3 = 6$ and $8 \times 0.5 = 4$.

The number of members that took more than one minute to run 400m

$$= 6 + 4$$

$$= 10.$$

The percentage of members that took more than one minute to run 400m

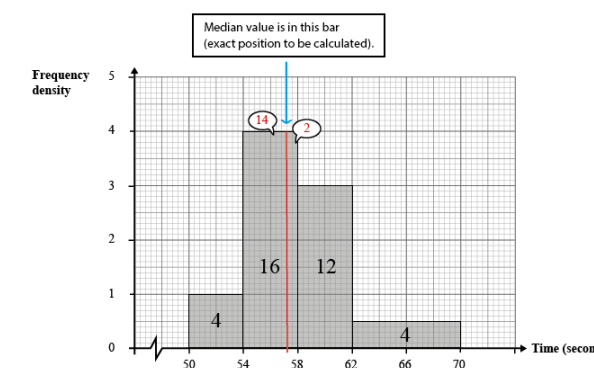
$$= \frac{10}{36} \times 100\% = 27.777777\ldots\%$$

$$= 28\% \text{ to the nearest whole number.}$$

Remember:

In a histogram, the area of the bars represents the frequency.
 Frequency density = frequency $\div$ class width.

To calculate an estimate of the median time taken by the under-30s to run 400m, we consider the following. As the median value is the middle value, we need to find the value which divides the total area in half. We therefore need the value with areas of $36 \div 2 = 18$ both below and above it.



By looking at the areas of the bars, since $4 + 16 = 20$, the median lies in the bar between 54 and 58 seconds.

For the second bar we need a frequency of 14, so we need to find w .

Where:

$$4 \times w = 14 \text{ then } w = 14 \div 4 = 3.5.$$

So, our estimate of the median is $54 + 3.5 = 57.5$ seconds.