

**10.1 Histograms**

A histogram looks similar to a bar chart but with one very important difference; on a bar chart the frequency is represented by *Height* but on a histogram the frequency is represented by *Area*.

**10.2 Example**

Over the course of a week a “screen time” survey is conducted into the number of hours that each person in a group of 214 people spent looking at their mobile phone. The results are summarised in a group frequency table and a histogram is to be drawn.

Screen time (hours)	Frequency (Number of people)	Width (hours)	Height Frequency Density (people per hour)
$0 < h \leq 5$	40		
$5 < h \leq 10$	35		
$10 < h \leq 20$	60		
$20 < h \leq 35$	24	15	1.6
$35 < h \leq 60$	55		

The class width column is filled in by noting, for example, that the class interval for  $20 < h \leq 35$  is 15.

For any rectangle,

$$\text{Area} = \text{Width} \times \text{Height}$$

which can be rearranged to make *Height* the subject of the formula,

$$\text{Height} = \frac{\text{Area}}{\text{Width}}$$

The teaching video begins with this formula recast in the form

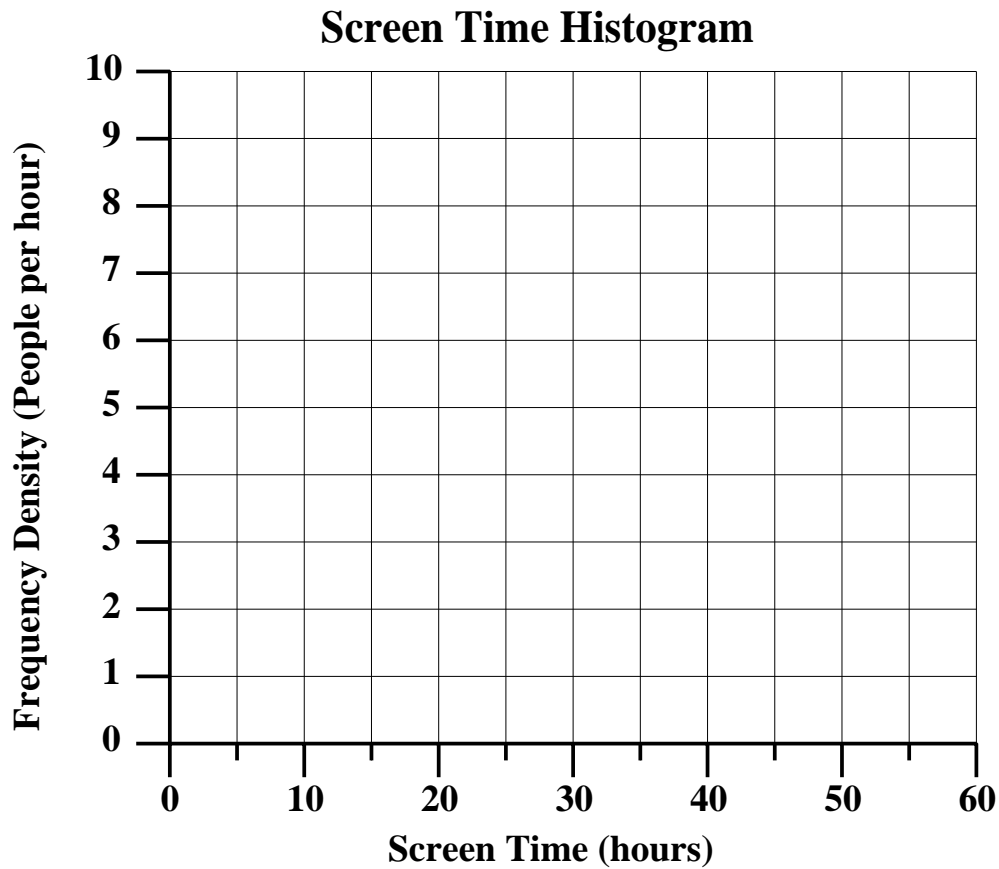
$$\text{Frequency Density} = \frac{\text{Frequency}}{\text{Class Width}}$$

As you watch the video you will see that the  $20 < h \leq 35$  class interval has a corresponding *Frequency Density* of,

$$\begin{aligned} \text{Frequency Density} &= \frac{24}{15} \\ &= 1.6 \text{ people per hour} \end{aligned}$$

- (i) Watch the video : [http://www.NumberWonder.co.uk/Video/v9037\(10\).mp4](http://www.NumberWonder.co.uk/Video/v9037(10).mp4)
- (ii) Complete the group frequency table, above.

(iii) Draw the histogram using the graph paper below.



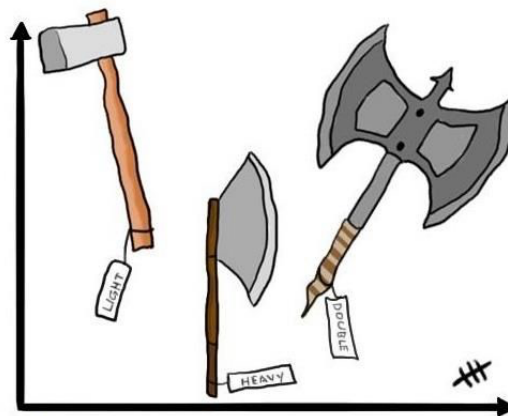
### 10.3 When to, and why, draw a histogram

A histogram should only be drawn for continuous data. There are many incorrect videos on the internet of histograms being drawn for discrete data.

A histogram, rather than a bar graph, is the correct diagram to draw when the class intervals are not all the same width. This is because the human eye looking at a rectangle finds it hard to only focus on height, it cannot help but see area.

### 10.4 And Don't Forget to....

#### Always label your axes



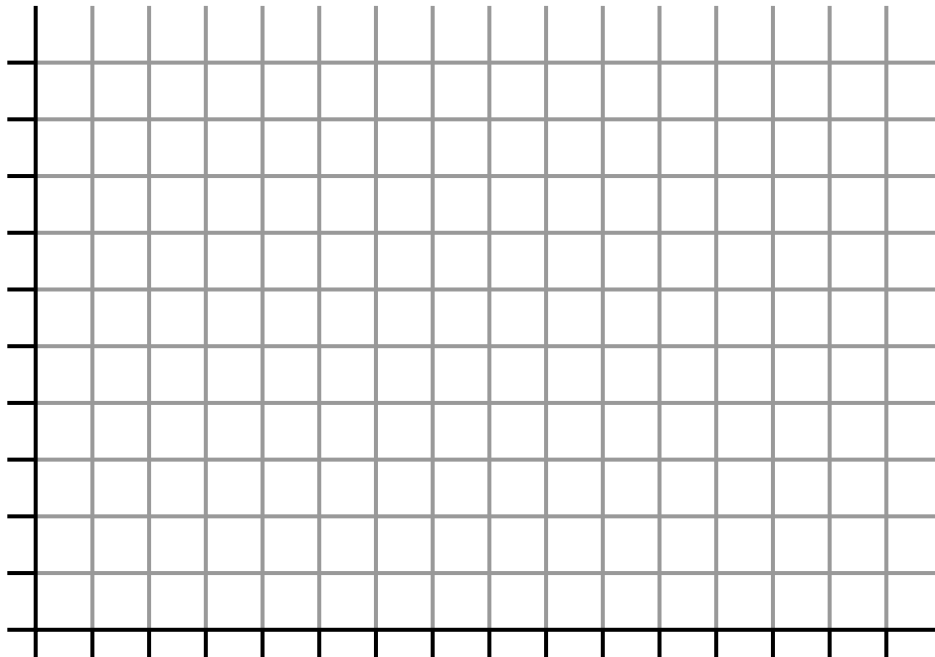
## 10.5 Exercise

### Question 1

At a call centre the times taken to deal with 1000 calls were as follows:

Duration of call (minutes)	Number of calls Frequency = Area	Width	Height
$0 \leq t < 2$	200		
$2 \leq t < 6$	300		
$6 \leq t < 10$	200		
$10 \leq t < 30$	300		

Plot a histogram to show the distribution of the 1000 call times at the centre. Be sure to number and label the axes and give the histogram a title.



### Question 2

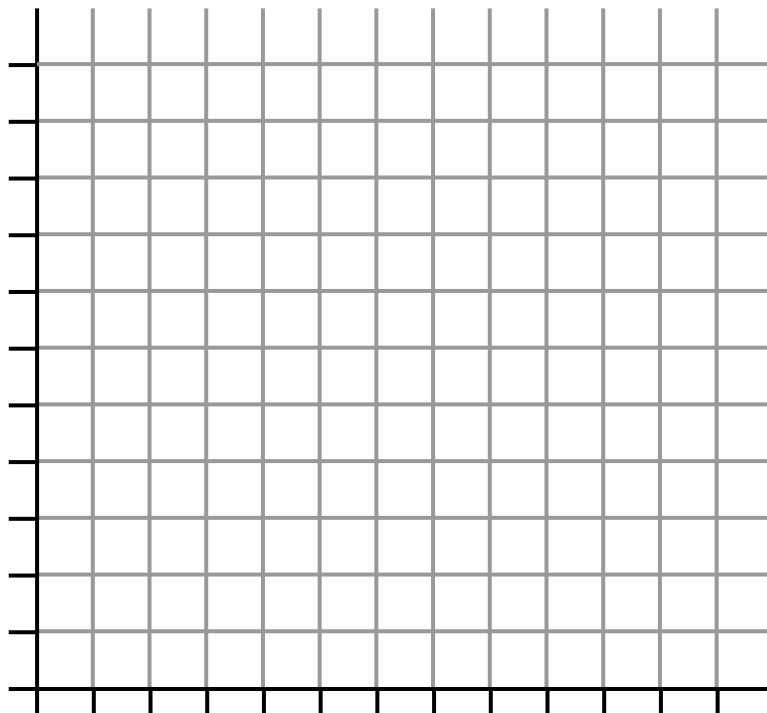
In a government survey, a questionnaire is emailed to 15000 people who have previously agreed to take part.

The time taken, in hours, to return the questionnaire is logged.

The following table presents a summary.

Response time (hours)	Number of questionnaires Frequency = Area	Width	Height
$0 \leq h < 2$	700		
$2 \leq h < 4$	1100		
$4 \leq h < 6$	2200		
$6 \leq h < 8$	1700		
$8 \leq h < 15$	3500		
$15 \leq h < 24$	2700		

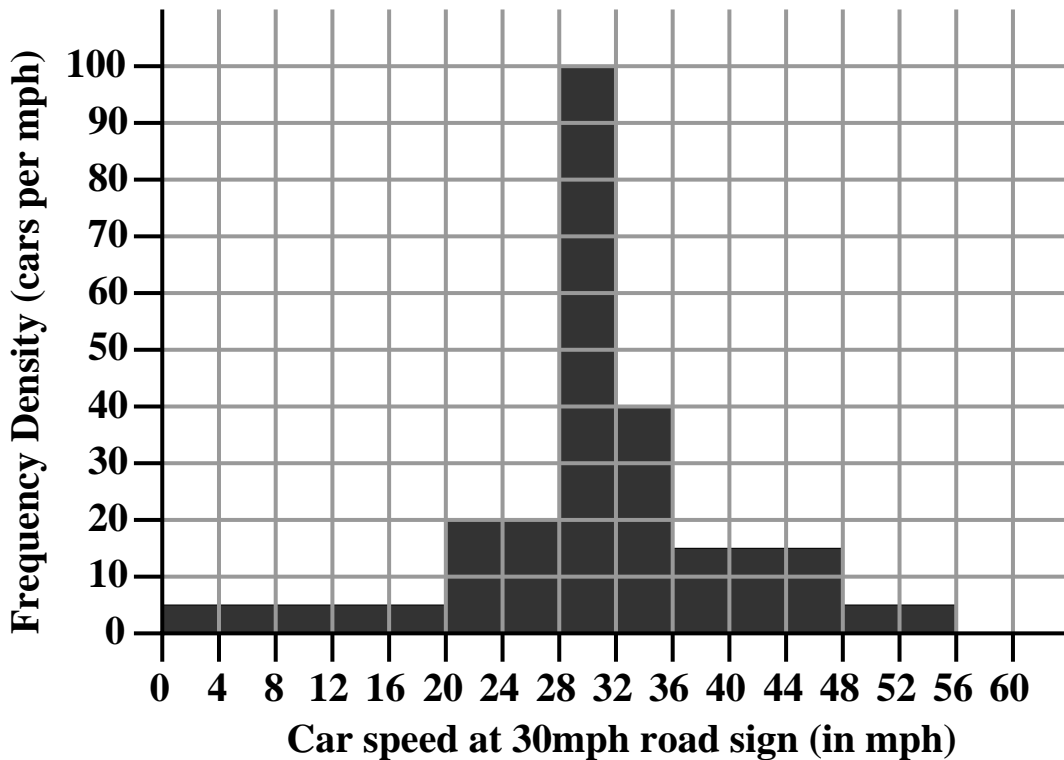
- (i) How many questionnaires have not generated a response ?
- (ii) Plot a histogram to show the distribution of the times taken in responding to the questionnaire. Complete the columns headed Width and Height in the table above to help you do this.



### Question 3

In trying to decide if a speed camera is required in the town of Numberville, a consultant provides the following histogram which shows the distribution of car speeds as cars pass the 30mph sign heading into Numberville.

**A histogram to show the distribution of car speeds at a 30mph road sign**



(i) Use the histogram to complete the following table :

Car speed (miles per hour, mph)	Number of cars Frequency = Area	Width	Height
$0 \leq m < 20$			
$20 \leq m < 28$			
$28 \leq m < 32$			
$32 \leq m < 36$			
$36 \leq m < 48$			
$48 \leq m < 56$			

(ii) How many cars in total had their speed recorded entering Numberville ?

(iii) What percentage of cars were travelling within 2mph of the speed limit ?

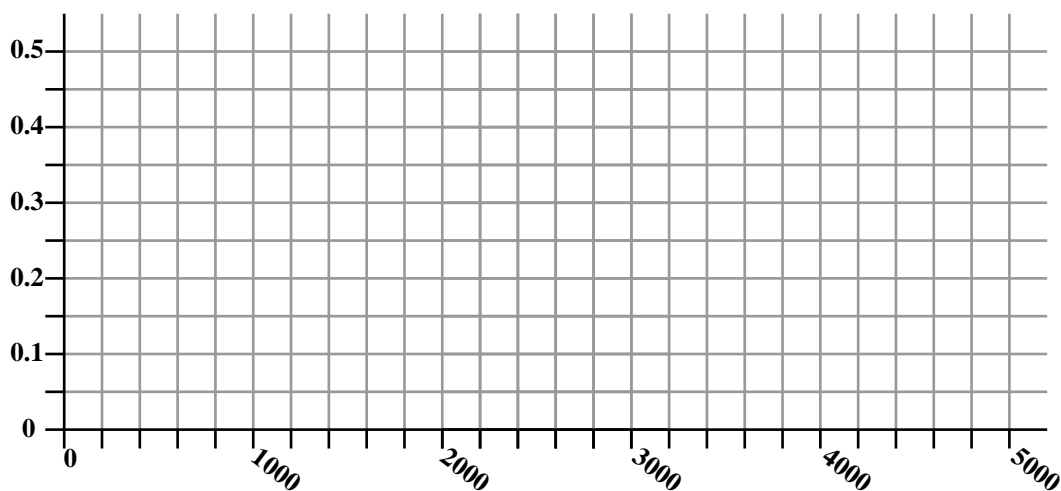
#### Question 4

As part of a quality control test, 1100 light bulbs are left on continuously and the time taken before they fail is recorded.

The results are summarised in the table below.

Bulb lifetime (in hours)	Number of bulbs Frequency	Width	Height
$0 \leq t < 100$	50		
$100 \leq t < 1000$	180		
$1000 \leq t < 2000$	100		
$2000 \leq t < 4000$	500		
$4000 \leq t < 4500$	250		
$4500 \leq t < 4600$	20		

Plot a histogram to show the distribution of the life-times of the bulbs. Complete the columns headed Width and Height in the table above, to help you do this.



Be sure to number and label the axes and give the histogram a title.

This document is a part of a **Mathematics Community Outreach Project** initiated by Shrewsbury School

It may be freely duplicated and distributed, unaltered, for non-profit educational use

In October 2020, Shrewsbury School was voted "**Independent School of the Year 2020**"

© 2022 Number Wonder

Teachers may obtain detailed worked solutions to the exercises by email from [mhh@shrewsbury.org.uk](mailto:mhh@shrewsbury.org.uk)

Video "Drawing Histograms" © 2012 Corbettmaths