

Maths activity: Bar charts and standard deviation

Skills: Maths and revision

Read through the attached pages and, using your note-taking abilities, complete the activities below.

Complete the practice questions thorough the pages

Produce a revision resource answering the following questions (Should you be changing your revision style, do you need to try a new revision technique- look at revision section on Connect)

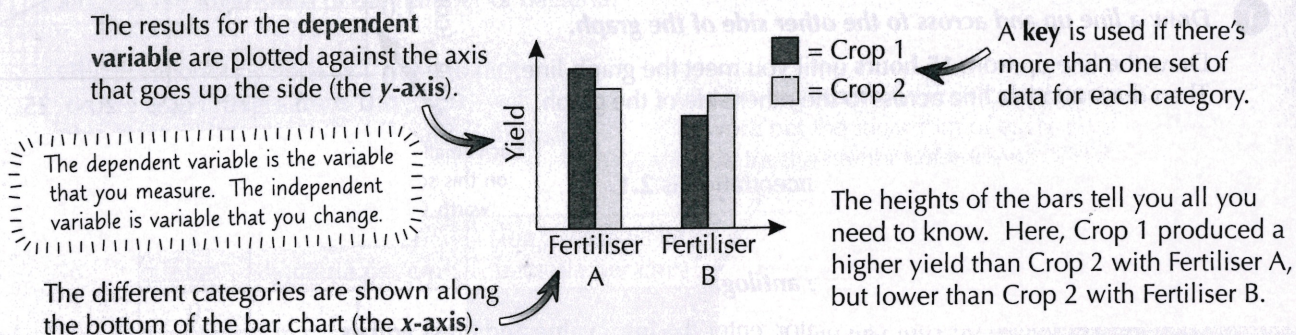
- What type of data is represented by a bar chart?
- What does a bar height indicate?
- How do you draw a bar chart from a table?
- How do you read from a bar chart?
- What data is shown in a histogram?
- How do you draw a histogram from a table?
- How do you read a histogram?
- Define standard deviation
- What is the standard deviation calculation? What do the letter represent?
- What does standard deviation show you/ allow you to do with your data?

Bar Charts

First up — **bar charts**. Drawing and understanding them isn't too tricky at all if you know how.

Bar Charts Let You Compare Data by Looking at the Bar Heights

Bar charts are great for presenting **categorical data** (data that falls into **categories**, like gender or plant species) or **discrete data** (numerical data that can only take **certain values** in a range, like shoe size or number of patients). Here's what your average bar chart may look like:



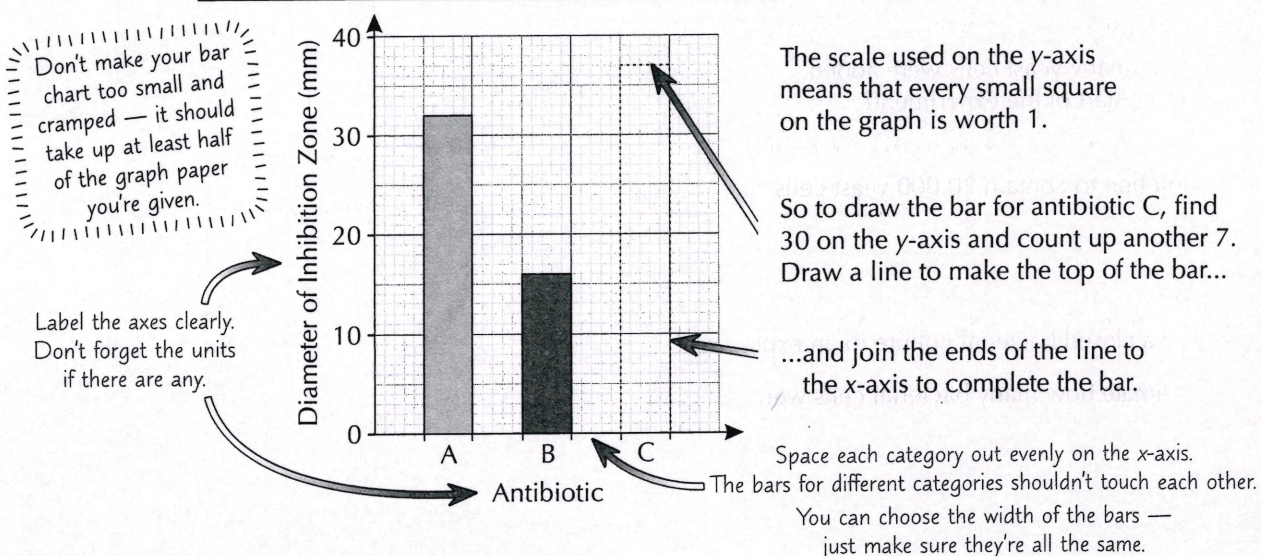
Choose a Sensible Scale to Make the Best Use of Your Graph Paper

If you need to draw a bar chart from a table of data, here's what you do:

Antibiotic	Diameter of Inhibition Zone / mm
A	32
B	16
C	37

These are the categories.

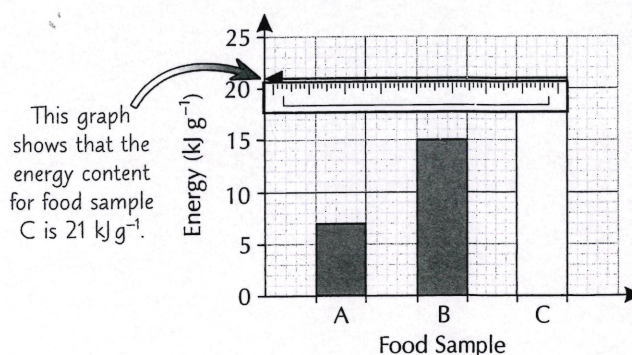
You need to choose a **sensible scale** for your y-axis. The highest number here is 37, so an axis running from 0 to 40 would work nicely.



Reading From a Bar Chart is Easy

If you need to **read** from a bar chart, you won't go wrong if you do these things:

- 1) Work out the **scale** on the y-axis.
- 2) Pick the bar you want to read from.
- 3) Line up a ruler with the **top** of the bar.
- 4) Read across from the top of the bar to the value on the **y-axis**.



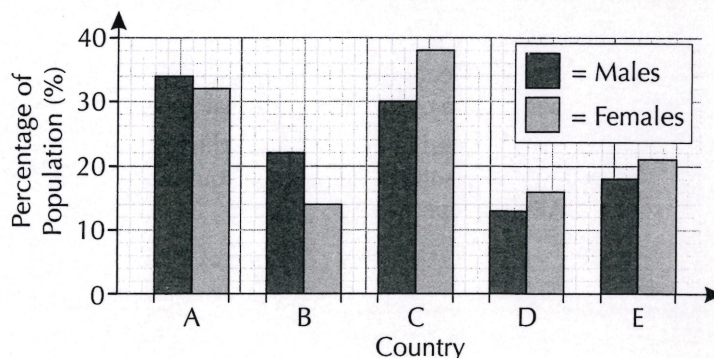
Bar Charts

Worked Example 1

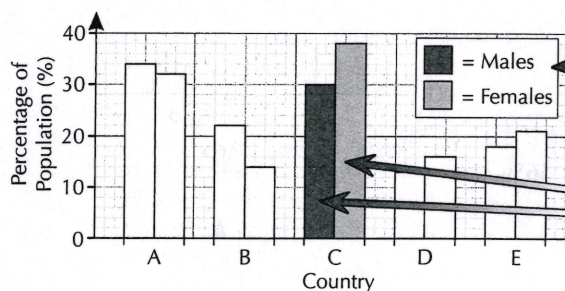
The percentage of the male population and female population who are obese was recorded for five different countries.

The results are shown in the graph on the right.

What is the difference between the percentage of males and females that are obese in country C?



- 1 Find the bars you need to look at.



The key tells you that for each category one column shows the number of males and the other column shows the number of females.

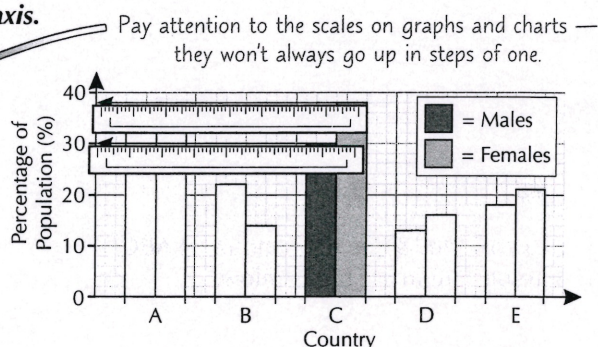
These two columns show the results for country C.

- 2 Read across from the top of the bars to the y-axis.

The scale on the y-axis means that every small square on the graph represents 2%.

The percentage of females in country C that are obese is 38%.

The percentage of males in country C that are obese is 30%.



Pay attention to the scales on graphs and charts — they won't always go up in steps of one.

- 3 Subtract the smaller value from the larger value to get the difference.

$$38 - 30 = 8\%$$

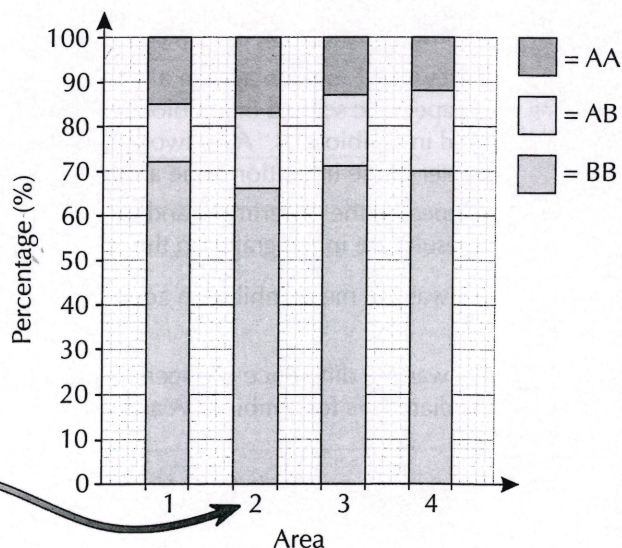
Worked Example 2

A gene coding for squirrel coat colour has three genotypes — AA, AB and BB. The graph on the right shows the frequency of each genotype in squirrel populations from four different areas.

What percentage of squirrels in area 2 have the AB genotype?

- 1 Find the bar you need to look at.

The question asks about the squirrels in area 2, so you need to look at the second bar.



Bar Charts

2 Find the section of the bar you need to look at.

The **height** of each section of the bar represents the percentage of squirrels with that genotype.

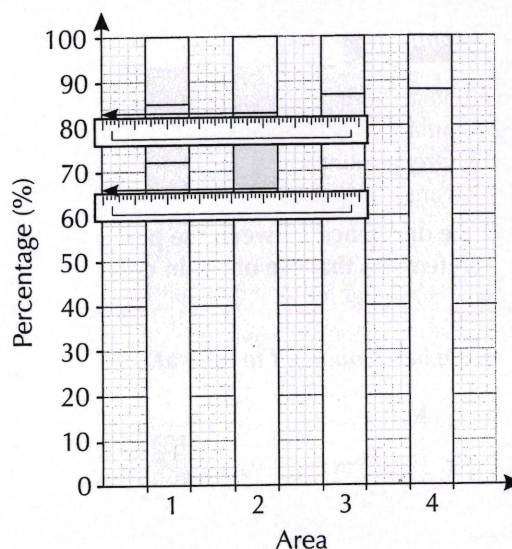
You're interested in the section of the bar that represents the percentage of squirrels with the AB genotype.

3 Read across from the top and bottom of the section to the y-axis.

The scale on the y-axis means that every small square on the graph represents **2%**.

The y-axis value at the top of the section is **83%**.

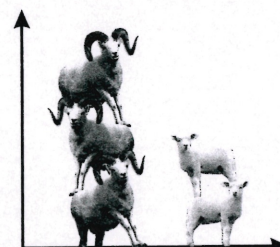
The y-axis value at the bottom of the section is **66%**.



4 Subtract the lower value from the higher value to get the answer.

$$83\% - 66\% = 17\%$$

Don't forget to include the % sign in your answer.



Don't know about you, but I love a good baa chart.

Practice Questions

- Q1 Nadia collected some data about the ABO blood types of students in her class. Her results are in the table below.

Blood group	A	B	AB	O
Number of students	16	12	4	19

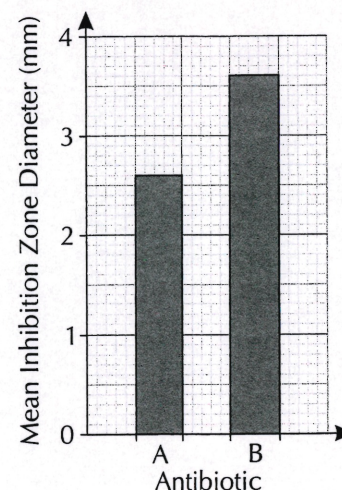
- Draw a bar chart to display the results in the table.
- Why is a bar chart a suitable way to display these results?

- Q2 Aisha was investigating the effectiveness of two different antibiotics against the bacterium *E. coli*.

She grew the *E. coli* on agar in a Petri dish and applied one paper disc soaked in antibiotic A and one paper disc soaked in antibiotic B. After two days she measured the diameter of the inhibition zone around each disc.

She repeated the experiment and took the mean of her results. Her results are in the graph on the right.

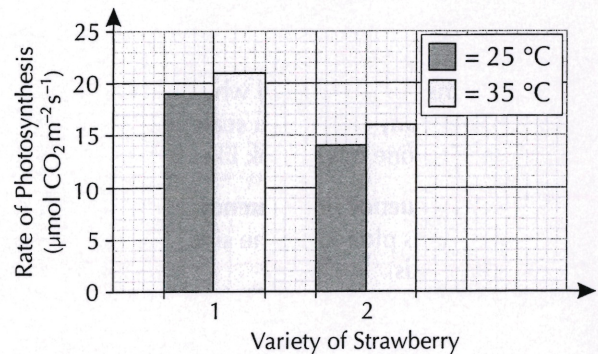
- What was the mean inhibition zone diameter for antibiotic B?
- What was the difference between the mean inhibition zone diameters for antibiotic A and antibiotic B?
- What can you conclude from Aisha's experiment by looking at the graph?



Bar Charts

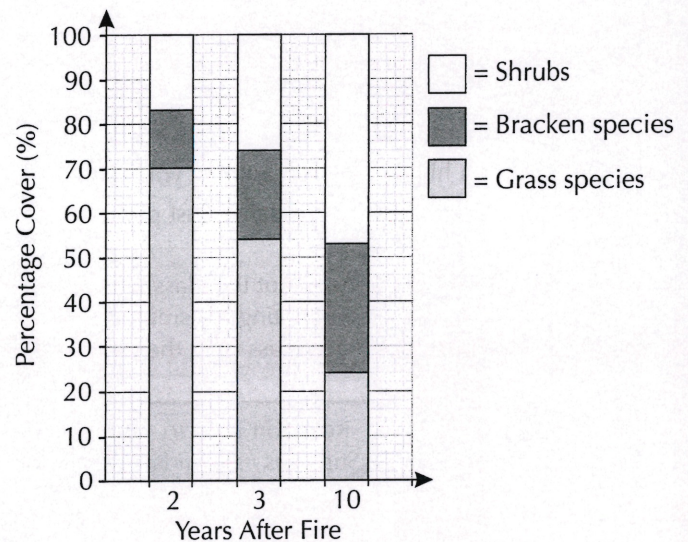
Q3 An agricultural scientist was investigating the effect of temperature on the rate of photosynthesis in different varieties of strawberry. The graph below shows his results for two varieties.

- a) What is the difference in the rate of photosynthesis at 25 °C for strawberry varieties 1 and 2?
- b) The rate of photosynthesis for variety 3 was $15 \mu\text{mol CO}_2 \text{m}^{-2} \text{s}^{-1}$ at 25 °C and $7 \mu\text{mol CO}_2 \text{m}^{-2} \text{s}^{-1}$ at 35 °C. Copy the graph and complete it by including the results for variety 3.



Q4 An investigation was carried out into secondary succession following controlled burning on a grassland site. Some of the results are shown in the graph on the right.

- a) What was the percentage cover of:
- grass species 3 years after the fire?
 - bracken species 2 years after the fire?
 - shrubs 10 years after the fire?
- b) How much more grassland was covered by bracken species 10 years after the fire compared to 3 years after the fire?



Q5 Ross conducted a survey about smoking in his town. His results are shown in the table below.

Age Group	Percentage of Population Who Smoke / %	
	Males	Females
16-25	11	12
26-35	21	13
36-45	18	12
46-55	10	5
56+	9	5

You'll need to include a key with your graph.

Draw a fully labelled bar chart to show the data in the table. The age groups should be labelled along the x-axis.

Barring charts, my favourite thing to draw is cats...

Spotting patterns in a table full of data can be a tricky task. It's a lot easier if you display it in some sort of graph. If your data has distinct values or categories, stick it in a bar chart. It has the added bonus of making results look really pretty.

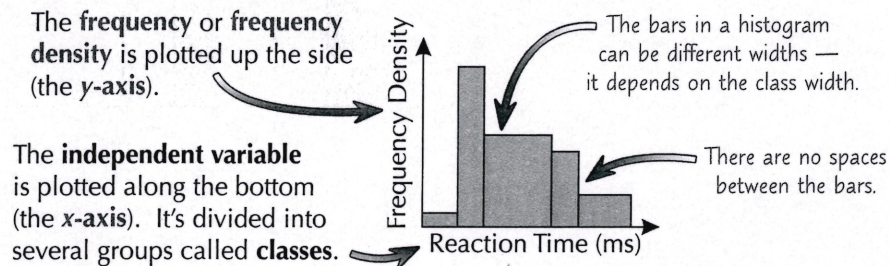
Histograms

Histograms look a bit like bar charts, but don't be fooled.

With Histograms it's the Area NOT the Height that Matters

Histograms come in useful when the **independent variable** is **continuous** (it can have **any value** on a **scale**, e.g. time or height).

Here's what one might look like:



Don't be tricked by the taller bars — they won't necessarily show the higher frequencies. It's all about the **area** of the bar. So you need to look at both the height and the width of the bar.

Area = width × height

Constructing a Histogram Involves some Calculations

Before drawing a histogram from a table, you need to look at the **class widths**. Here's what to do with them:

- 1) If the class widths are all the **same**, just pop the **frequency** on the y-axis and choose a **suitable scale** for your x-axis.

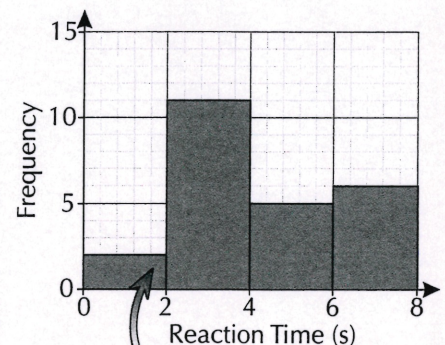
Work out the class width by subtracting the smallest number in each class from the largest number.

This is one class.

The inequalities tell you the upper and lower limits of each class.
 $\leq$ means 'less than or equal to' and $<$ means 'less than'.

Reaction Time to Stimulus / seconds	Frequency	Class Width
$0 \leq x < 2$	2	$2 - 0 = 2$
$2 \leq x < 4$	11	$4 - 2 = 2$
$4 \leq x < 6$	5	$6 - 4 = 2$
$6 \leq x < 8$	6	$8 - 6 = 2$

All the classes are the same width.



Draw the bars in the same way as a bar chart (see p. 36).

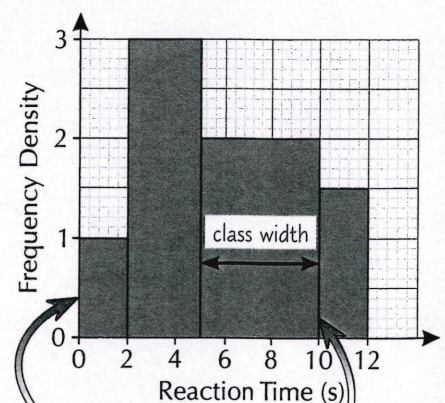
- 2) If the class widths are **different**, you need to work out the **frequency density**. To do that, you use this **formula**:

$$\text{frequency density} = \text{frequency} \div \text{class width}$$

Reaction Time to Stimulus / seconds	Frequency	Class Width	Frequency Density
$0 \leq x < 2$	2	$2 - 0 = 2$	$2 \div 2 = 1$
$2 \leq x < 5$	9	$5 - 2 = 3$	$9 \div 3 = 3$
$5 \leq x < 10$	10	$10 - 5 = 5$	$10 \div 5 = 2$
$10 \leq x < 12$	3	$12 - 10 = 2$	$3 \div 2 = 1.5$

Work out the class widths...

...then work out the frequency density.



The height of each bar is the frequency density.

The width of each bar is the class width.

Histograms

Pay Attention to the y-axis When You're Reading from a Histogram

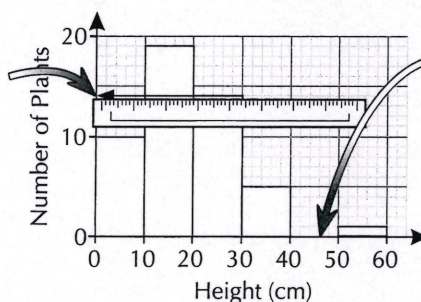
If you want to read data off a histogram, have a look at the **y-axis**.

If it shows the **frequency** (because the class widths are all equal), just do these things:

- 1) Work out the **scale** on the y-axis.
- 2) Pick the **class** you want to read from.
- 3) Read across from the top of the bar to the value on the **y-axis**.

Like with bar charts, a ruler can help you read across to values on the y-axis.

14 plants were between 20 cm and 30 cm tall.



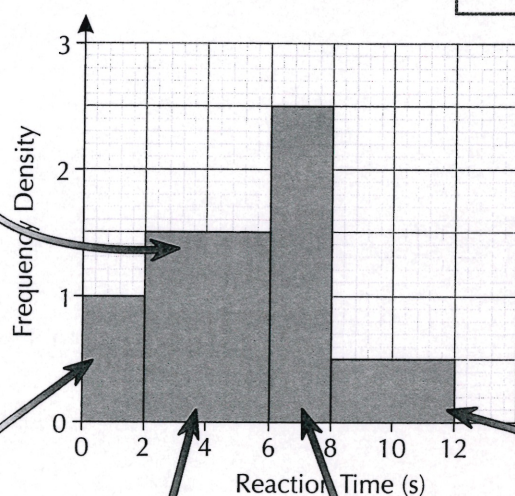
A gap means that there are no results in that class. Here, no plants had a height between 40 cm and 50 cm.

When the y-axis shows the **frequency density**, you need the frequency density formula again.

To work out the frequency of a class, just switch the formula around:

$$\text{frequency} = \text{frequency density} \times \text{class width}$$

The frequency for each class is represented by the area of the bar.



Class width = $2 - 0 = 2$
and frequency density = 1.
So, frequency = $2 \times 1 = 2$.

Class width = $6 - 2 = 4$
and frequency density = 1.5.
So, frequency = $4 \times 1.5 = 6$.

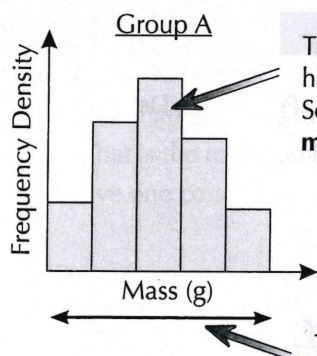
Class width = $8 - 6 = 2$
and frequency density = 2.5.
So, frequency = $2 \times 2.5 = 5$.

Class width = $12 - 8 = 4$
and frequency density = 0.5.
So, frequency = $4 \times 0.5 = 2$.

Data with unequal classes is plotted using frequency density because otherwise the heights of the bars would be distorted.

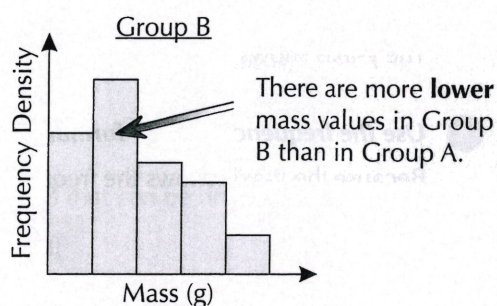
The Shape of a Histogram Can Tell You Things

The **shape** of a histogram can tell you more about the data. For example:



The class with the **largest area** has the highest frequency. So this class contains the **most** mass values.

The value of the **width** of the histogram shows the **range** of the results (how spread out they are).



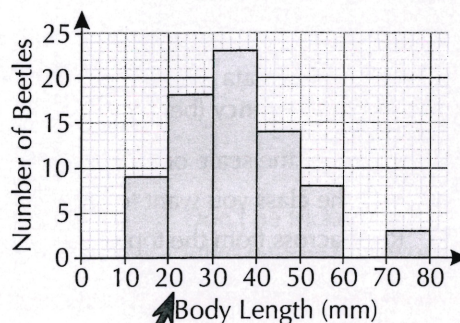
There are more **lower** mass values in Group B than in Group A.

Histograms

Worked Example 1

Morgana was investigating the effect of body length on reproductive fitness in a species of beetle. The histogram on the right shows the body lengths of all the beetles included in her study.

How many beetles were between 30 and 50 mm long?



- 1 **Find the classes you need to look at.**

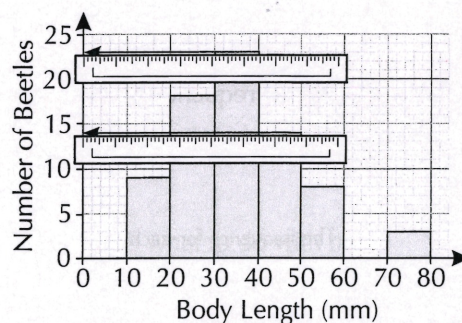
Body lengths between 30 mm and 50 mm are covered by two classes.

- 2 **Read across from the top of the bars to the y-axis.**

The y-axis shows the frequency, so you don't need to do anything with the values.

23 beetles were between 30 and 40 mm long.

14 beetles were between 40 and 50 mm long.



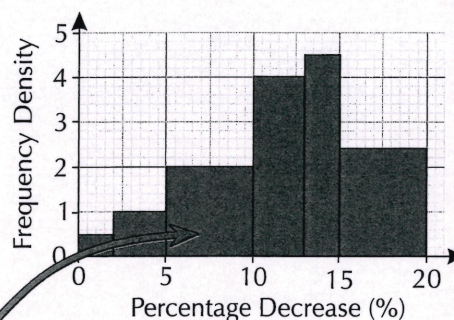
- 3 **Add the values together to get the answer.**

$$23 + 14 = 37 \text{ beetles}$$

Worked Example 2

The effect of drug X on the size of tumours in patients with skin cancer was investigated. The volume of each patient's tumour was recorded at the beginning of the study and again after four months of treatment. The percentage decrease in tumour size was then calculated for each patient. The results are shown in the histogram on the right.

How many patients had a percentage decrease of between 5% and 10%?



- 1 **Find the class you need to look at.**

The percentage decrease between 5% and 10% is covered by just one class.

- 2 **Read across from the top of the bar to the y-axis.**

The y-axis shows the **frequency density**, which for this class is 2.

- 3 **Use the frequency density formula to find the frequency.**

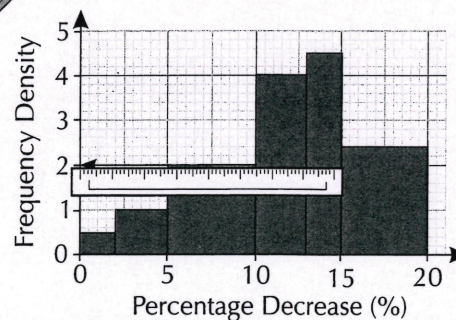
Because the y-axis shows the frequency density, you need to use this formula:

$$\text{frequency} = \text{frequency density} \times \text{class width}$$

$$2 \times 5 = 10 \text{ patients}$$

frequency density

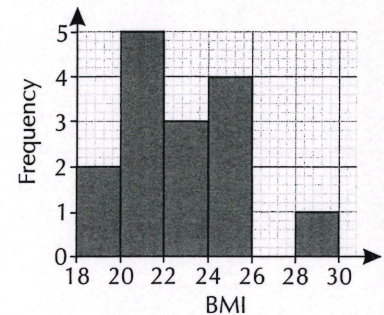
class width ($10 - 5 = 5$)



Histograms

Practice Questions

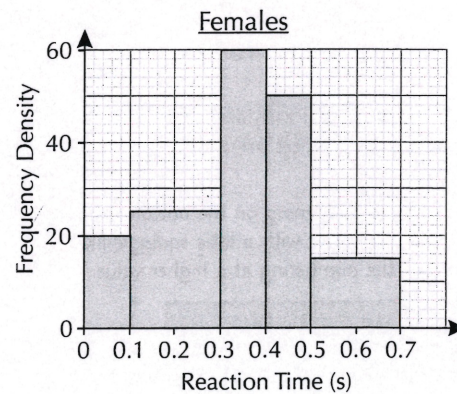
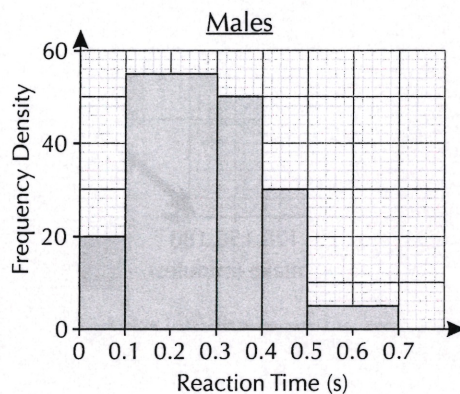
- Q1 A student was investigating the BMI values of her classmates. Her results are shown in the histogram on the right.
- Which histogram class contains the most common BMI value?
 - How many more students had a BMI between 24 and 26 compared to the number of students with a BMI between 28 and 30?
 - What percentage of the students had a BMI between 20 and 22? Give your answer to the nearest whole number.



- Q2 A biologist was studying the heights of pine trees in a forest. His results are shown in the table below.

Height / m	Frequency	Class Width	Frequency Density
$0 \leq x < 2$	1		
$2 \leq x < 5$	5		
$5 \leq x < 10$	7		
$10 \leq x < 15$	4		
$15 \leq x < 25$	2		

- Copy the table and complete the two empty columns.
 - Use your completed table to draw a histogram of the biologist's results. The y-axis should show the frequency density.
- Q3 A biologist was studying the difference in reaction times of males and females. Participants were asked to press a button in response to a flash of light. The results of the experiment are shown in the histograms below.



- How many females had a reaction time of less than 0.4 seconds?
- What is the total number of males represented in the histogram?
- Give one conclusion about the reaction times of males and females that can be drawn from the two graphs.

More bars to draw? You're having a graph...

Don't let histograms catch you out — before you do anything else, take a good look at the y-axis. If it's showing the frequency density, you've got a bit of calculating to do to work out the frequency before you can write down any answers.