Data

Curriculum Ready

Mathletics

www.mathletics.com

DATA

Data is another word for 'information.' In terms of data, this information is usually a list of numbers called 'scores.' This chapter will show you how to analyse sets of data using their scores.

Answer these questions, *before* working through the chapter.

I used to think:

The word 'mean' is another word for 'average.' What is the mean of a set of data?

Why would a set of scores need to be arranged in ascending order?

What is a histogram?

Answer these questions, *after* working through the chapter.

But now I think:

The word 'mean' is another word for 'average.' What is the mean of a set of data?

Why would a set of scores need to be arranged in ascending order?

What is a histogram?

? *What do I know now that I didn't know before?*

Data and Frequency

A set of data is just a list of numbers which are called 'scores'.

For example, if 20 students had an assignment out of 10, then the data representing their results could be:

9	0	3	6	4	8	2	10	7	6	5	5	8	1	8	7	9	4	7	0

The *frequency* of a score is the amount of times it appears in the list. So the score 6 has a frequency of 2 in the list above, since it appears twice. A **frequency table** displays the frequency of each score. Here is a frequency table for the above list.

Score (x)	Frequency (f)
0	2
1	1
2	1
3	1
4	2
5	2
6	2
7	3
8	3
9	2
10	1
Total	20

The frequency total should always be the same as the amount of scores in the data. This is a good way to check yourself.

Cumulative Frequency

The 'Cumulative frequency' of a score is the sum of the frequencies for all scores less than or equal to that score. Here is the same table as above, with an extra column for *cumulative frequency*.

Score (x)	Frequency (f)	Cumulative Frequency (cf)
0	2	2
1	1	$1 + 2 = 3$
2	1	4
3	1	$1 + 4 = 5$
4	2	7
5	2	9
6	2	11
7	3	14
8	3	$3 + 14 = 17$
9	2	19
10	1	20
$\sum f = 20$		

To complete this column add the frequency of the current score to the previous cumulative frequency.

$\sum$ is the Greek letter 'sigma.' It means 'sum of', so $\sum f$ means 'sum of frequencies'.

The last score's cumulative frequency should be the same as the frequency total and the number of scores in the data.

1. The data below represents how many fish some fisherman caught in a week:

3   6   5   2   1   8   4   3   5   3   4   7   0   4   1

Complete this frequency and cumulative frequency table:

Score (x)	Frequency (f)	Cumulative Frequency (cf)
0		
1		
2		
3		
4		
5		
6		
7		
8		
	$\sum f =$	

---

2. This data was collected for the different ages of some random university students.

19   18   20   21   22   20   19   24   21   22   23   20   23   21   19

a   Complete the table below and use it to answer the questions that follow:

Score (x)	Frequency (f)	Cumulative Frequency (cf)
18		
19		
20		
21		
22		
23		
24		
	$\sum f =$	

b   How old were the youngest and oldest student?

c   How many students were 22 or younger?

3. Draw a frequency distribution table for the set of data: 3 6 5 2 1 8 4 3 5 3 4 7 0 4 1

4. Complete the tables below:

ⓐ Use the frequency to complete the cumulative frequency column:

f	cf
2	
3	
1	
2	
3	
2	
1	

ⓑ Use the cumulative frequency to complete the frequency column:

f	cf
	3
	4
	6
	8
	10
	13
	16

5. Is it possible for:

a The cumulative frequency of a score to be **larger than** its frequency? Briefly explain.

b The cumulative frequency of a score to be **the same as** its frequency? Briefly explain.

c The cumulative frequency of a score to be **smaller than** its frequency? Briefly explain.

Mean, Median, Mode

The mean of a data set is written as $\bar{x}$ (pronounced 'x-bar'). It is the arithmetic average of the data set.

$$\bar{x} = \frac{\text{sum of scores}}{\text{number of scores}} \qquad \text{or} \qquad \bar{x} = \frac{\sum x}{n} = \frac{\sum x}{\sum f}$$

where $\sum x$ means 'sum of scores' and $n = \sum f$ is the number of scores.

Find the mean ($\bar{x}$) of the following data sets

a   3   4   2   6   9   0   4   3   5

$$\bar{x} = \frac{\sum x}{n} = \frac{3+4+2+6+9+0+4+3+5}{9}$$
$$= \frac{36}{9}$$
$$= 4$$

b   5   3   6   7   4   7   1   2   7   1

$$\bar{x} = \frac{\sum x}{n} = \frac{5+3+6+7+4+7+1+2+7+1}{10}$$
$$= \frac{45}{10}$$
$$= 4.3$$

The Median is the middle score of an ordered set. To find it, arrange the data in ascending order and pick the middle score. If there is an even number of scores, then the median is the average of the two scores in the middle.

If n is odd, then the median is the score in position $\frac{n+1}{2}$. If n is even, then the median is the average of the scores in position $\frac{n}{2}$ and $\frac{n}{2} + 1$.

Find the median of the following data sets

a   3   4   2   6   9   0   4   3   5

Arrange in ascending order

0   2   3   3   ④   4   5   6   9

   middle score

∴ The median is 4.

b   5   3   6   7   4   7   1   2   7   1

Arrange in ascending order

1   1   2   3   ④   ⑤   6   7   7   7

   middle two scores

∴ The median is $\frac{4+5}{2} = 4.5$.

The Mode is the score with the highest frequency. The Mode is the score that appears the **most**. A set could have no modes (equal frequency for all scores) or have more than one mode (more than one score with the highest frequency).

Find the mode of the following data sets

a   3   4   2   6   9   0   4   3   5

3 and 4 have the highest frequency (2)

∴ 3 and 4 are modes of this data set.

b   5   3   6   7   4   7   1   2   7   1

7 has the highest frequency (3)

∴ 7 is the mode of this data set.

These 3 statistics have a fancy name. They are called **measures of central tendency.**

Finding the Mean, Median and Mode from a Frequency Table

Sometimes a data set could be very large and so we would use a frequency table to find the measures of central tendency. Look at the table below:

Score (x)	Frequency (f)	fx	Cumulative Frequency (cf)
2	6	$2 \times 6 = 12$	6
3	4	$3 \times 4 = 12$	10
5	7	$5 \times 7 = 35$	17
7	9	$7 \times 9 = 63$	26
8	4	$8 \times 4 = 32$	30
	$n = \sum f = 30$	$\sum fx = 154$	

The third column is a new column. It contains the product of the score and its frequency.

The **mean** of data in a frequency table is $\bar{x} = \dfrac{\sum fx}{\sum f}$

To find the **median** use the cumulative frequency to determine the score in the middle position.

To find the **mode**, just identify the score with the highest frequency.

Use the data set above to find the mean, median and mode of the data set

- The **mean** for the above data set is $\bar{x} = \dfrac{\sum fx}{\sum f} = \dfrac{154}{30}$
$$= 5.1$$

- In the table above:

  $\sum f = 30$. So there are 30 scores in the data set. This is an even number.

  $\therefore$ the median will be the average of the scores in 15th and 16th position.

  Since the cumulative frequency of 5 is 17, it means that the score in 15th and 16th position is 5.

  $\therefore$ the **median** is $\dfrac{5+5}{2} = 5$

- In the table above, 7 has the highest frequency (9). So the **mode** of the data is 7.

The **range** of a set of data is the difference between the highest score and the lowest score.

So, for the above table:

$$\text{Range} = \text{HighestScore} - \text{Lowest Score}$$
$$= 8 - 2$$
$$= 6$$

1. Answer these questions in your own words.

a   What is the mean of a data set?

b   What is the median of a data set?

c   What is the mode of a data set?

d   What is the range of a data set?

e   What do $\sum f$ and $\sum fx$ mean?

2. A teacher records the percentages that a group of students achieved in a test.

75   80   62   65   71   91   88   55   48   42   63   80   78   66   52

a Find $\bar{x}$, the mean of the data set.

b Arrange the data set in ascending order.

c Find the median of the data set.

d Find the mode(s) of the data set.

3. Complete the following frequency distribution table.

Score (x)	Frequency (f)	fx	Cumulative Frequency (cf)
11	10		
14	11		
16	9		
17	7		
19	11		
20	15		
21	8		
	$n = \sum f =$	$\sum fx =$	

a What is the range of this data set?

b Find $\bar{x}$.

c How many scores are in the data set?

d In which position is the median score and what is the median?

e What is the mode of the data set?

4. Look at this data set: 5   3   8   4   8   1   7   9   0   5.

a   Find $\bar{x}$.

b   If an 11th score of 6 was added to the data set, is the new mean greater than, equal to or less than the original mean? Why?

c   If an 11th score of 5 was added to the data set, is the new mean greater than, equal to or less than the original mean? Why?

d   If an 11th score of 4 was added to the data set, is the new mean greater than, equal to or less than the original mean? Why?

5. This data set shows how many points a team scored each week over a 4 week period: 210 320 100 220.
How many points do they need to score in the 5ᵗʰ week to ensure that the mean score over 5 weeks is 200 points?

6. How many scores are in a data set if:

a　The median is the 17ᵗʰ score in an ordered data set?

b　The median is the average of the 20ᵗʰ and 21ˢᵗ score in the data set?

Frequency Histograms and Polygons

These are diagrams based on frequency (or cumulative frequency). They are drawn based on a frequency table.

A *Histogram* is a column graph of all the scores in a data set.

A *Polygon* is a line graph joining frequencies.
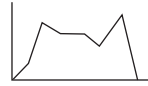
Histograms and polygons can be drawn on the same set of axes. The table below was used to draw a histogram and a polygon for frequency. They have been drawn on the **same axes.**

Score (x)	Frequency (f)	Cumulative Frequency (cf)
2	4	4
4	8	12
5	1	13
6	3	16
7	6	22
9	5	27
10	3	30

$$n = \sum f = 30$$

Frequency Histogram and Polygon

The lines form the **polygon**

Half column here

The columns form the **histogram**

Half column here
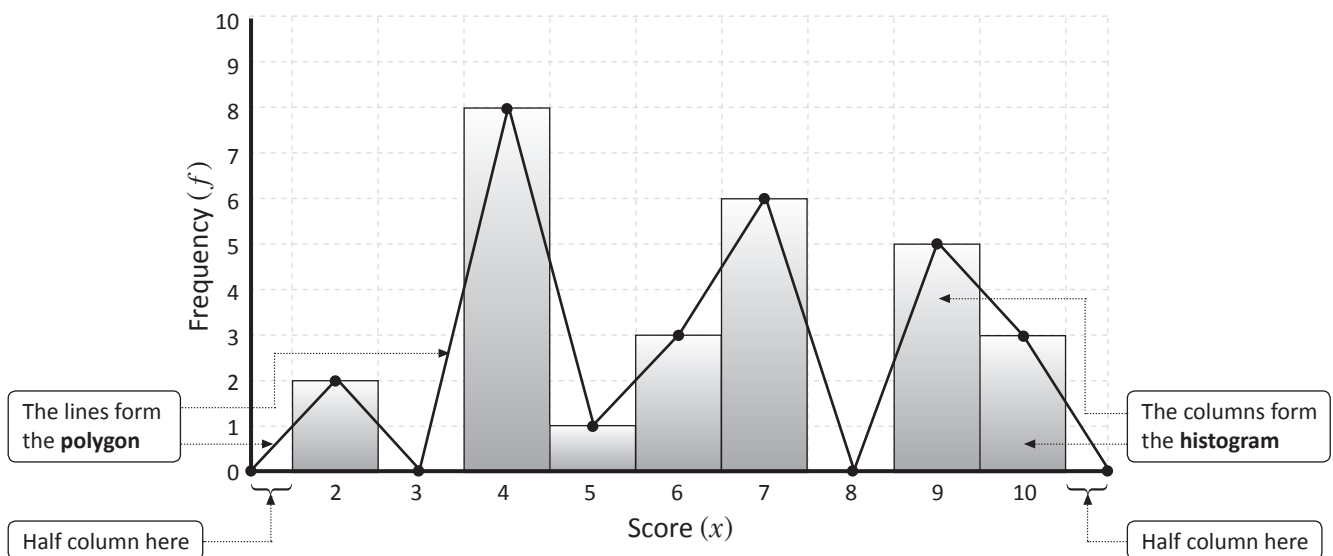
Note: Scores 3 and 8 had no frequency but were within the range of scores, so need to be included on the graph with a 0 frequency.

Important things to remember for FREQUENCY:

- There is half a column "empty" on each side of the histogram.
- The polygon starts from 0 at the bottom left corner.
- The polygon returns to 0 at the end.
- The polygon joins the centre of each column.

Cumulative Frequency Histograms and Polygons

We can also draw histograms and polygons for cumulative frequency. This histogram was drawn using the cumulative frequency column, in the table on the previous page.

Cumulative Frequency Histogram and Polygon
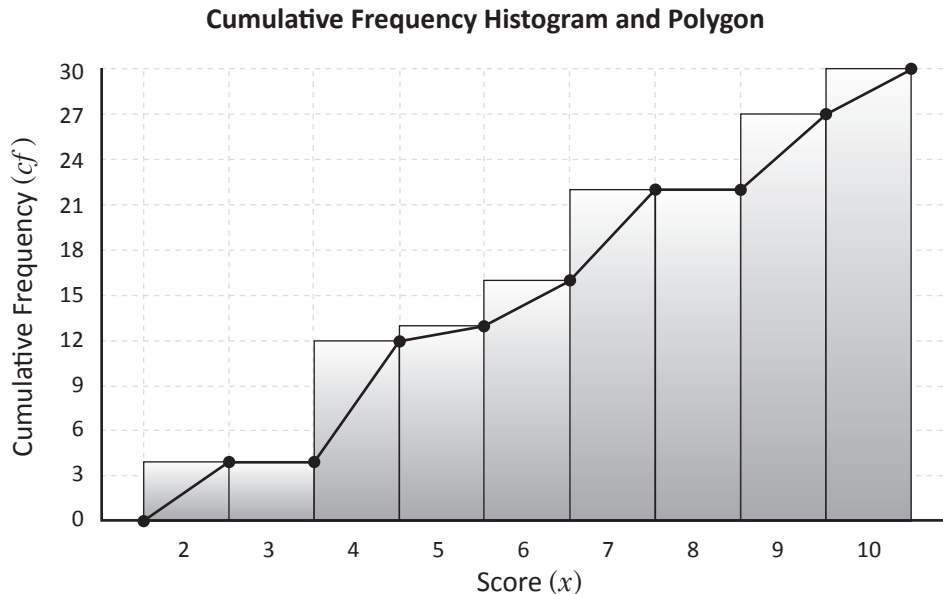
Note: Polygon is flat (no increase) for scores 3 and 8 as they do not have any frequency.

**Important things to remember for CUMULATIVE FREQUENCY:**

- There is half a column 'empty' on each side of the histogram.

- The polygon starts from the beginning of the histogram.

- The polygon **does not** return to 0 at the end.

- The polygon joins the right corner of each column.

- The graph moves upwards in steps. (Why?)

- A cumulative frequency polygon is also called an **ogive.**

Important Rules for Histograms and Polygons

- Each histogram or polygon must have a title.

- Make sure you label the x-axis (usually scores) and y-axis (usually frequency or cumulative frequency)

- Be careful of the scale on the y-axis.

- Don't forget that a polygon in a frequency histogram goes through the centre of the columns, and a polygon in a cumulative frequency histogram goes through the **top right corner** of the columns.

Reading Histograms and Polygons

Look at this cumulative frequency histogram and polygon. What is the total amount of scores in the data set?

Rolls of a die
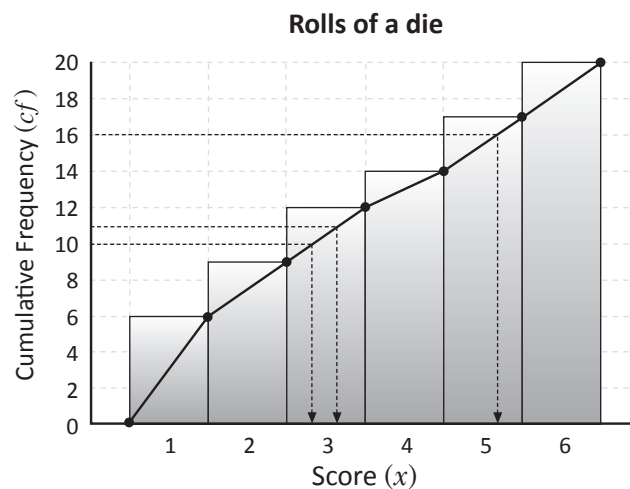
There are 20 scores. We know this because in the diagram, the cumulative frequency of the highest score (6) is 20.

We can also use ogives to determine the score in a specific position. Here is an example using the above diagram.

What is the score in the 16th position in the ordered data set?

- If we draw a horizontal line from 16 on the y-axis, then we see that this line first goes through the column representing the score '5'.

- This line ALSO intersects the ogive over the score '5.'

So the score in the 16th position is 5.

The rule in the previous example can be applied to all positions.

For any n: The nth score of an ordered data set can be found by drawing a horizontal line from n on the y-axis.

The nth score is one of the following: • Represented by the *first* column the horizontal line cuts (histogram)
                                               • The value over which the horizontal line cuts the ogive (polygon)

Answers these questions from the diagram

a Find the score in the 10th position of the ordered data.

Draw a horizontal line from 10 on the y-axis. It can be seen the score in the 10th position is 3.

b Find the score in the 11th position of the ordered data.

Draw a horizontal line from 11 on the y-axis. It can be seen the score in the 11th position is 3.

c Find the median of the data set.

Since there are 20 (even) scores in the data set, the median is the average of the scores in the 10th and 11th positions.
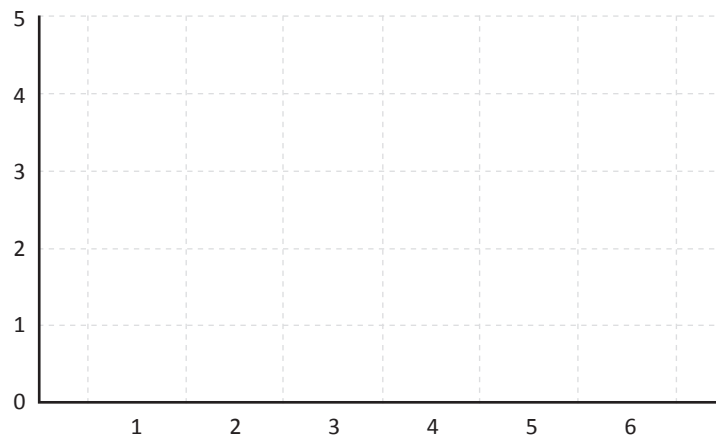
$$\text{Median} = \frac{10^{th}\text{ score} + 11^{th}\text{ score}}{2} = \frac{3 + 3}{2} = 3$$

**1. A single die was rolled 15 times and these were the results: 1 6 4 2 4 1 5 3 3 2 6 5 4 3 1.**

a Complete this table for the data:

Score (x)	Frequency (f)	Cumulative Frequency (cf)
1		
2		
3		
4		
5		
6		
	$\sum f =$	

b Use the table to complete a frequency histogram and polygon on the same axes below.
(hint: don't forget the title and labels)

c Use the table to draw a histogram for cumulative frequency and an ogive on the same axes.
(hint: don't forget the title and labels)
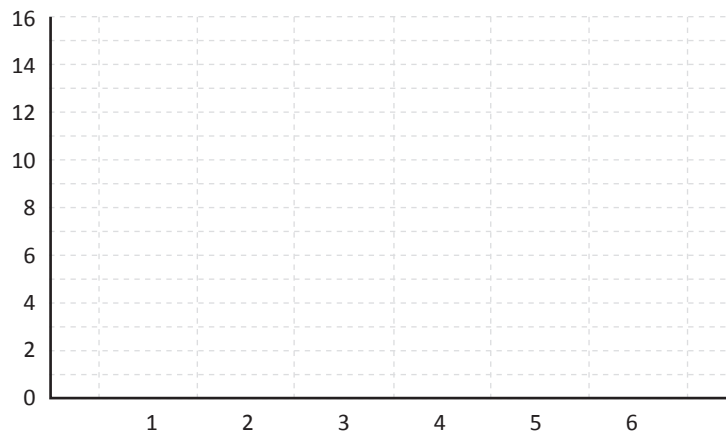
d There are 15 scores in the data set. In which position of the ordered data set is the median?

e Use the diagram in **c** to find the median of this data set.

....

2. Draw in the ogive in each of the following and use it to find the median.

a

Scores

Median =

b

Scores

Median =
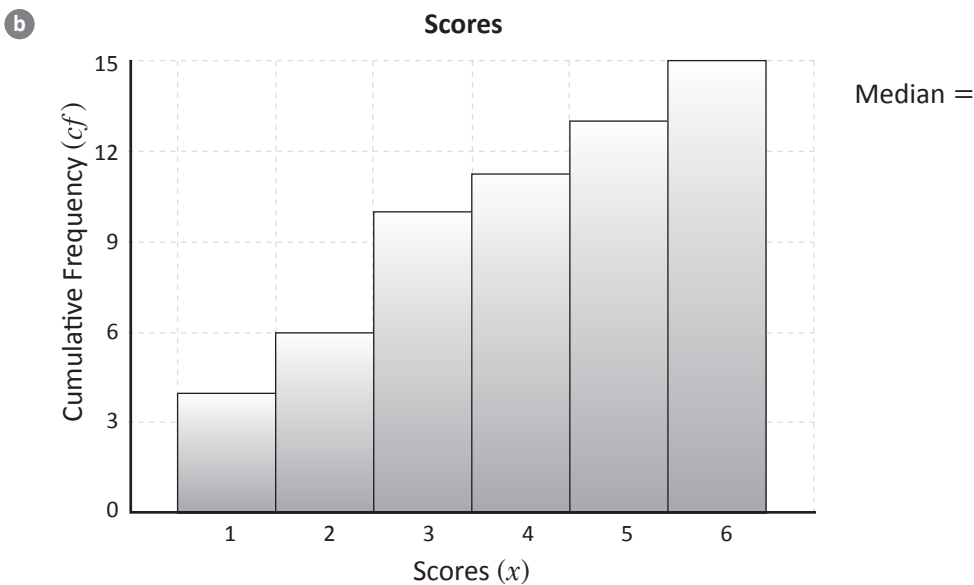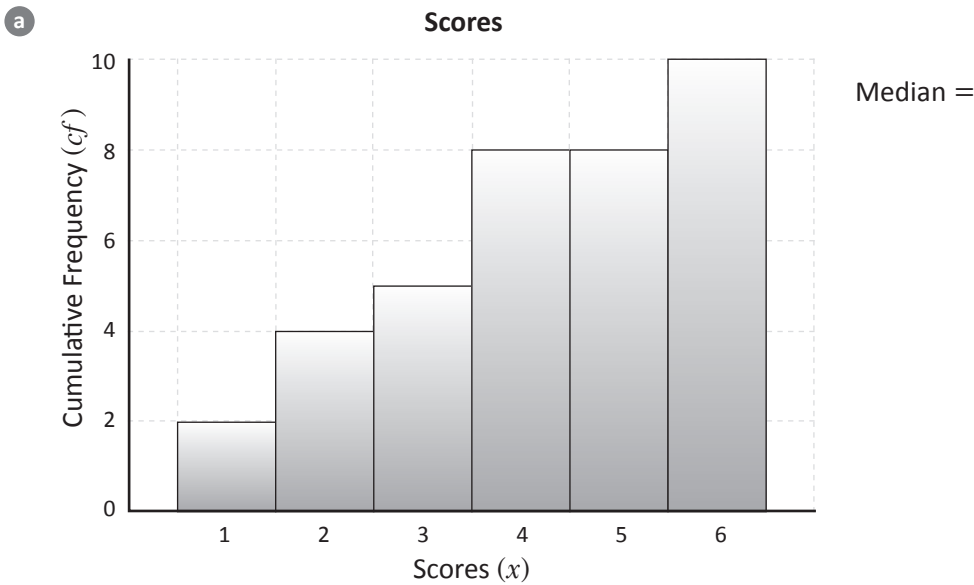
3. The frequency histogram of the different heights (in m) of a group of students is represented below.

Student Height Measurement

Student Height Measurement
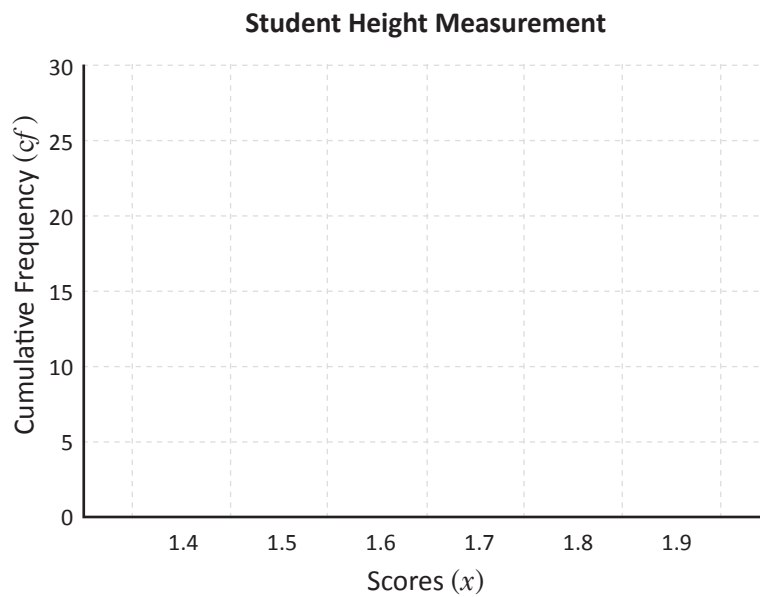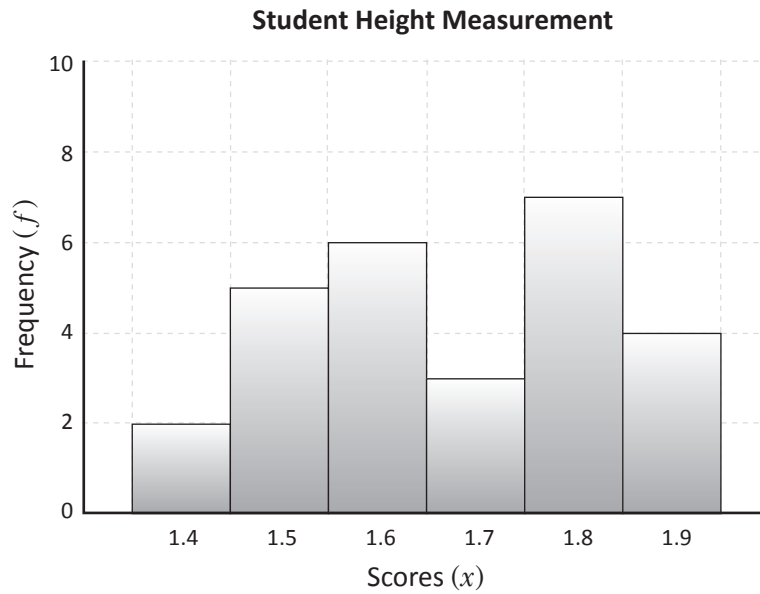
a How many students were measured for their height? (How many scores are in the data set?)

b Complete the cumulative frequency histogram on the other set of axes.

c Complete the polygon in each diagram.

d What is the median of this set of data?

Grouped Data

Sometimes when the range of scores is very big, the data is grouped into smaller ranges called 'classes.' For example, if people between the ages of 1 and 50 attended a movie, then a frequency table with 50 rows is inefficient.

A quicker option is to group the data into $1-10$, $11-20$, $21-30$, $31-40$ and $41-50$. This way a frequency table would only have 5 rows. These groups are called "classes". Here is an example:

Thirty nine people with the following ages attended a movie

12	10	21	22	31	35	18	40	32	16
18	17	15	25	27	28	37	32	28	30
20	19	17	21	29	23	34	33	9	26
22	36	28	21	37	39	22	10	11	

Complete the following table:

Class	Frequency (f)	Cumulative Frequency (cf)
$1-10$	3	3
$11-20$	10	13
$21-30$	15	28
$31-40$	11	39
	$\sum f = 39$	

Each class has a class centre. It is found by adding the first number and last number in a class and dividing by 2. The class centre is represented in the table by x.

Extra columns for the class centre (x) and frequency $\times$ class centre (fx) have been added to the above table. Complete these new columns

Class	Class Centre (x)	Frequency (f)	fx	Cumulative Frequency (cf)
$1-10$	$\frac{1+10}{2} = 5.5$	3	$3 \times 5.5 = 16.5$	3
$11-20$	$\frac{11+20}{2} = 15.5$	10	$10 \times 15.5 = 155$	13
$21-30$	$\frac{21+30}{2} = 25.5$	15	$15 \times 25.5 = 382.5$	28
$31-40$	$\frac{31+40}{2} = 35.5$	11	$11 \times 35.5 = 390.5$	39
		$\sum f = 39$	$\sum fx = 944.5$	

Finding the Mean

It might seem like we are adding these columns for no reason but they are actually used to estimate the mean of the data set.

Although the mean can't be found using the table, a very close estimate can be found using the formula.

$$\bar{x} = \frac{\sum fx}{\sum f}$$

Use the ages in the frequency table (previous example) to estimate the mean age

$$\bar{x} = \frac{\sum fx}{\sum f}$$

$$= \frac{944.5}{39}$$

$$= 24.22 \;(2 \text{ d.p.})$$

The Modal Class

Instead of finding a single score to be the mode, the modal class is the class with the highest frequency.

The modal class of the set of data in the example on the previous page is $21-30$.

The Median Class

The median class is the class which contains the median. Remember, the position and cumulative frequency of a score are related. So, the median class is the class whose cumulative frequency passes through the median position.

The median class can be found from the table by:

• Identifying the position of the median from the total number of scores

• Identifying which class contains that position, from the cumulative frequency

Find the median class in the example using the table

• There are 39 scores in total, so the median is in the 20th position.

• The class $11-20$ has a cumulative frequency of 13 and the class $21-30$ has a cumulative frequency of 28.

• So $21-30$ contains the 20th score. Therefore $21-30$ is the median class.

Histograms and Polygons

Histograms and polygons can be drawn for grouped data too.
They work in the same way, the **only difference is that the class centres replace the scores** on the x-axis.

Use the table in the example to draw a histogram and polygon (on the same axes) the people's ages who attended the movie. (The data set in the table)

Ages

Ages

"class centres" replaces "scores"
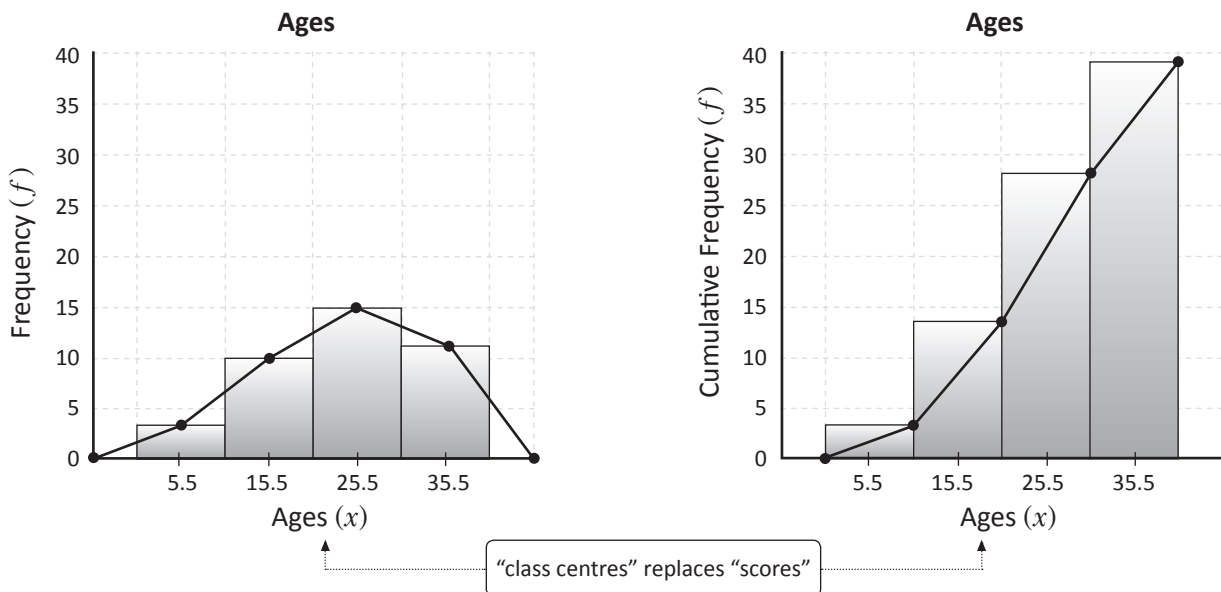
Important things to remember for these histograms and polygons are the same as in the previous section for ungrouped data.

The cumulative frequency polygon (ogive) can also be used to estimate the median of the data set. This is done in the same way as ungrouped data.

Use the ages in the frequency table (previous example) to estimate the mean age.
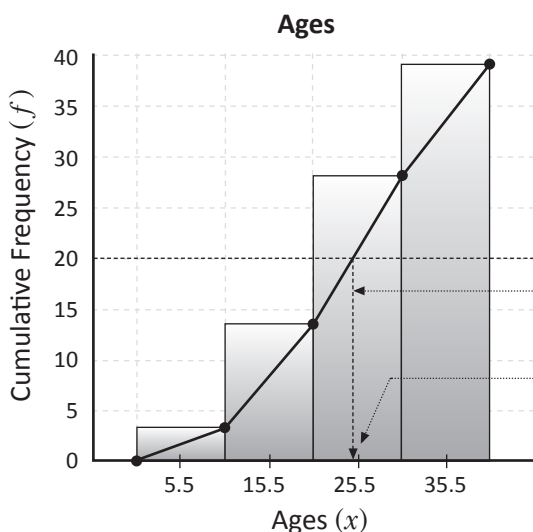
Ages

- There are 39 ages (scores) so the median is in the 20th position (middle)

- Draw a horizontal line from 20 on the y-axis.

- We can tell the median class is $21-30$ since this is the class in which the horizontal line cuts the ogive.

- Draw a vertical line from where the lines cut down to the x-axis to estimate the median.

- The arrow hits just left of 25.5 so a good estimate of the median is 25.

1. When a frequency polygon is drawn, it returns to 0 at the end, but this does not happen with cumulative frequency polygons. What are some other differences we must remember when drawing these diagrams?

2. Explain the difference between the following:

a 'Class' and 'Class Centre'.

b 'Mode' and 'Modal Class'.

c 'Frequency' and 'Cumulative Frequency'.

3. A magician asked sixty people to pick a number from 1 to 92. These are the numbers they chose:

3	56	38	54	23	52	87	66	55	42	29	39	24	74	60
58	61	18	29	51	37	31	78	54	27	73	62	41	25	32
52	48	6	17	23	47	51	88	16	5	12	36	58	81	74
36	59	41	75	63	25	1	78	90	47	53	65	26	20	15

a List 4 classes to group these scores into.

b Fill these classes in the first column of the table below:

Class	Class centre (x)	Frequency (f)	fx	Cumulative Frequency (cf)
		$\sum f =$	$\sum fx =$	

c What is the meaning of 'fx' in the 4th column?

d Find the class centre of each class and fill these in on the table in the second column.

e Fill in the rest of the table.

f Estimate the mean. (How would you find the exact value of the mean using the original scores?)

g Which class is the modal class? Why?

h Which class is the median class? Why?

4. During a recent game of darts some scores were recorded.

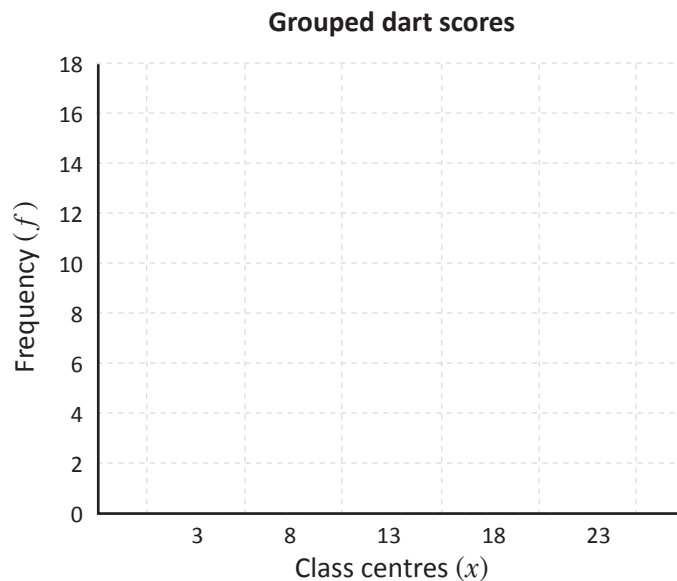Use the provided data to fill in blank values in the table below:

(a)

Class	Class Centre (x)	Frequency (f)	fx	cf
1−5		12		
6−10				29
11−15		9		
16−20				43
21−25		8		
		$\Sigma f =$	$\Sigma fx =$	

(b) Estimate the mean

(c) Which is the modal class?

(d) Draw a frequency histogram and polygon on the same axes below (remember to fill in the class centres):

Grouped dart scores

Frequency (f) axis: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18

Class centres (x): 3, 8, 13, 18, 23

e Complete a cumulative frequency histogram and polygon on the axes below:

Group dart scores

Cumulative Frequency (f)

60
50
40
30
20
10
0

3   8   13   18   23

Class centres (x)
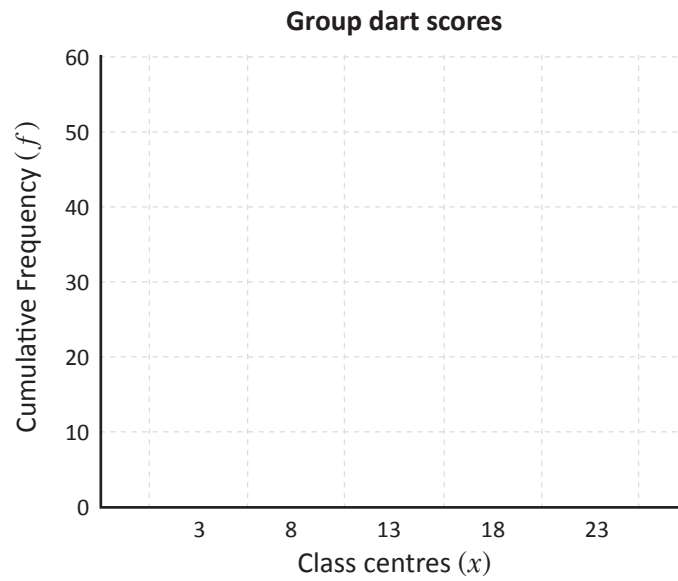
f What is the total number of scores?

g Which position will the median be placed in the ordered set of scores?

h Use the cumulative frequency polygon to determine which is the median class.

i Use the diagram above to estimate the median.

100% Data
Mathletics 100%   © 3P Learning

MATHLETICS

Basics:

1.

Score (x)	Frequency (f)	Cumulative Frequency (cf)
0	1	1
1	2	3
2	1	4
3	3	7
4	3	10
5	2	12
6	1	13
7	1	14
8	1	15
	$\Sigma f = 15$	

2. **a**

Score (x)	Frequency (f)	Cumulative Frequency (cf)
18	1	1
19	3	4
20	3	7
21	3	10
22	2	12
23	2	14
24	1	15
	$\Sigma f = 15$	

b The youngest student was 18
The oldest student was 24

c 12 students were 22 or younger

3.

Score (x)	Frequency (f)	Cumulative Frequency (cf)
0	1	1
1	2	3
2	1	4
3	3	7
4	3	10
5	2	12
6	1	13
7	1	14
8	1	15
	$\sum f = 15$	

4. **a**

f	cf
2	2
3	5
1	6
2	8
3	11
2	13
1	14

Basics:

4. **b**

f	cf
3	3
1	4
2	6
2	8
2	10
3	13
3	16

5. **a** Yes. The cumulative frequency is the sum of the preceding frequencies, so it must be at least as big as the score

b Yes. The cumulative frequency will be the same as the frequency all rows up to first row where the score is not zero.

c No. The cumulative frequency of a score is the sum of the frequency, and all previous frequencies in the table. These frequencies are all positive integers or zero, so the sum can never be less than the frequency

Knowing More:

1. **a** The mean is what most people mean by average. Think of a batting average, you add up all the elements of a data set (the scores), and divide by the number of elements in the data set (the number of innings).

b The median is the middle value of a sorted data set. If there is an even number of members, calculate the average of the 2 middle scores.

c The mode is the most frequent member(s) of the data set, the score(s) that occurs the most number of times. If all scores have the same frequency, the data set has no mode.

d The range of the data set is the difference between the largest and the smallest members of a data set.

Knowing More:

1. e $\sum f$ means add up all of the frequencies in a data set

$\sum fx$ means multiply each value in the data set by its frequency then add all of these up.

2. a

Score (x)	f	fx	Cumulative Frequency (cf)
42	1	$42 \times 1 = 42$	1
48	1	$48 \times 1 = 48$	2
52	1	$52 \times 1 = 52$	3
55	1	$55 \times 1 = 55$	4
62	1	$62 \times 1 = 62$	5
63	1	$63 \times 1 = 63$	6
65	1	$65 \times 1 = 65$	7
66	1	$66 \times 1 = 66$	8
71	1	$71 \times 1 = 71$	9
75	1	$75 \times 1 = 75$	10
78	1	$78 \times 1 = 78$	11
80	2	$80 \times 2 = 160$	13
88	1	$88 \times 1 = 88$	14
91	1	$91 \times 1 = 91$	15
	$n = \Sigma f = 15$	$\Sigma fx = 1016$	

b

42	48	52	55	62	63
65	66	71	75	78	80
80	88	91			

c The median is the 'middle' value of the sorted data set. There are 15 values. The middle value is then therefore the eighth one, 66.

d The mode is the most frequent (common) value in the data set. 2 is the largest value in the frequency column above, and the mode is the corresponding f value, 80.

Knowing More:

3.

Score (x)	Frequency (f)	fx	Cumulative Frequency (cf)
11	10	$10 + 11 = 110$	10
14	11	$11 + 14 = 154$	21
16	9	$9 + 16 = 144$	30
17	7	$7 + 17 = 119$	37
19	11	$11 + 19 = 209$	48
20	15	$15 + 20 = 300$	63
21	8	$8 + 21 = 168$	71
	$n = \Sigma f = 71$	$\Sigma fx = 1204$	

a The range is 10

b $\bar{x} = 16.96$

c Total number of scores is 71

d The median is in position 36th
The median is 17

e The mode is 20

4. a $\bar{x} = 5$

b The new mean will be $5.\dot{0}\dot{9} > 5$

c The new mean will be the same ($= 5$)

d The new mean will be $4.\dot{9}\dot{0} < 5$

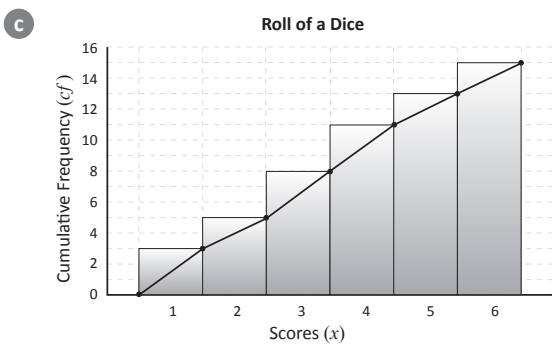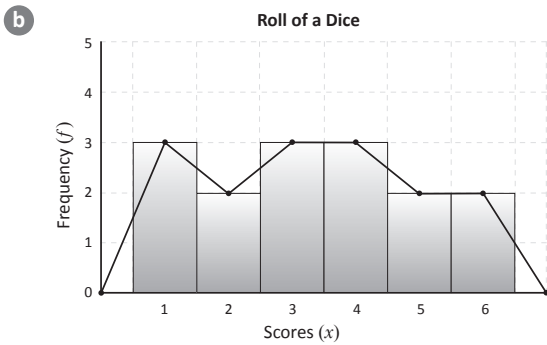**5.** The team must score 150 in the 5th week to have a mean of 200 over the 5 week period.

6. a 33 scores in the data set.
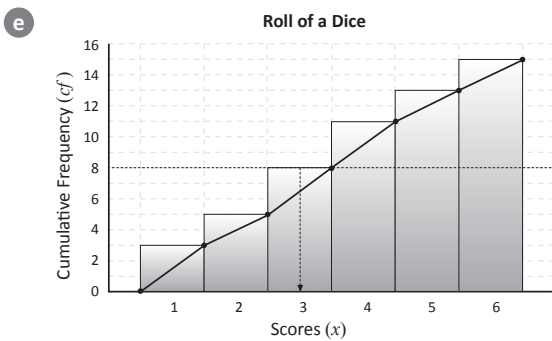
b 40 scores in the data set.

Using Our Knowledge:

1. **a**

Score (x)	Frequency (f)	Cumulative Frequency (cf)
1	3	3
2	2	5
3	3	8
4	3	11
5	2	13
6	2	15

$$\sum fx = 15$$

b

Roll of a Dice

c

Roll of a Dice

d The median is in the 8th position

e

Roll of a Dice

The median of this data set is 3.

Using Our Knowledge:

2. **a**

Scores

$$\text{median} = 3\frac{1}{2}$$

b

Scores

$$\text{median} = 3$$

3. **a** 27 students

b

Student Height Measurement

Using Our Knowledge:

3. **c**

Student Height Measurement
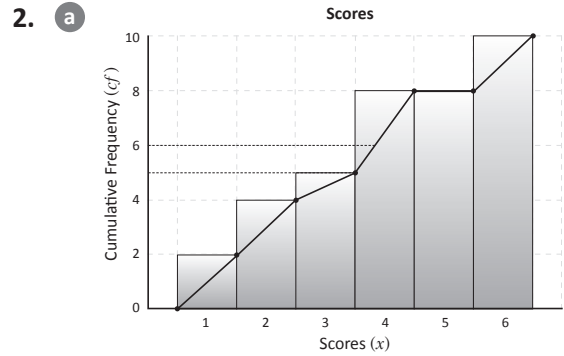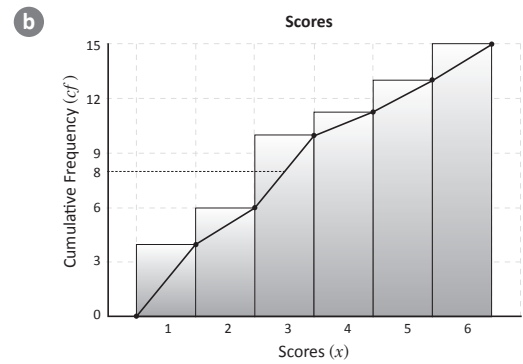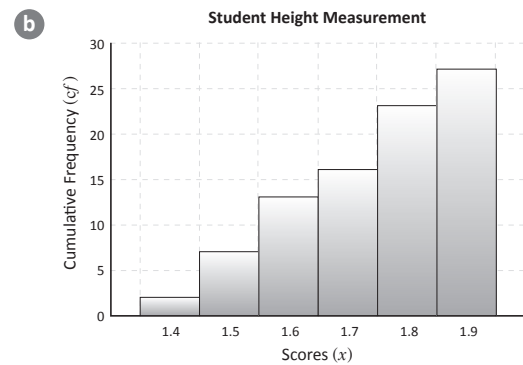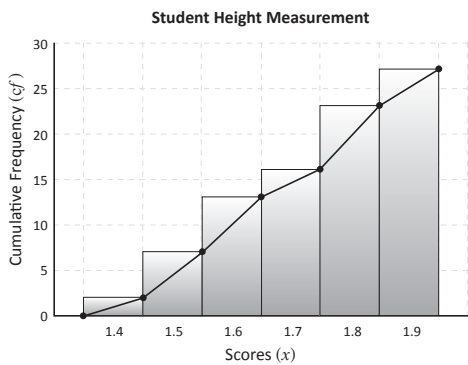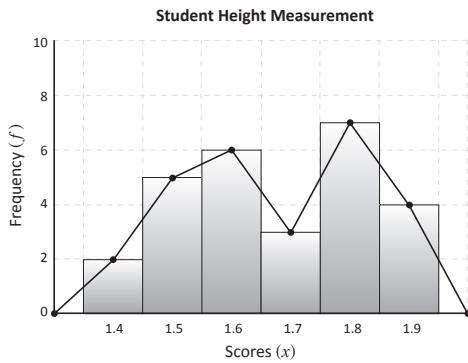
d The median of this set of data is 1.7m

Thinking More:

1. • The frequency polygon passes through the centre of the top of each column. The cumulative frequency polygon passes through the top right corner of each column.

• The frequency polygon starts half a column to the left of the first column, and finishes half a column to the right of the last column. The cumulative frequency polygon starts at the bottom left of the first column and ends at the top right corner of the last column.

2. **a** A 'Class' is convenient grouping of scores in a data set, say ages from $21-30$. The 'Class Centre' is a value that represents the middle of a 'Class'. For the $21-30$ class, the class centre is $\dfrac{21 + 30}{2} = 25.5$

Thinking More:

2. **b** The mode of a data set is the score(s) with the highest frequency. The Modal Class is the class that has the highest frequency.

c The frequency of a particular score is the number of times that the score occurs in a data set. The cumulative frequency of a score is the number of times that the score or any score smaller than it appears in the data set.

3. **a** The classes would be:

$[1-23]$ (23 values)

$[24-46]$ (23 values)

$[47-69]$ (23 values)

$[70-92]$ (23 values)

b

Class	Class Centre (x)	f	fx	cf
$1-23$				
$24-46$				
$47-69$				
$70-92$				
		$\Sigma f =$	$\Sigma fx =$	

c This means multiply the frequency by the class centre of the class.

d

Class	Class Centre (x)	f	fx	cf
$1-23$	$\dfrac{(1 + 23)}{2} = 12$			
$24-46$	$\dfrac{(24 + 46)}{2} = 35$			
$47-69$	$\dfrac{(47 + 69)}{2} = 58$			
$70-92$	$\dfrac{(70 + 92)}{2} = 81$			
		$\sum f =$	$\sum fx =$	

Thinking More:

3. **e**

Class	Class Centre (x)	f	fx	cf
1−23	$\frac{(1+23)}{2} = 12$	12	144	12
24−46	$\frac{(24+46)}{2} = 35$	17	595	29
47−69	$\frac{(47+69)}{2} = 58$	21	1218	50
70−92	$\frac{(70+92)}{2} = 81$	10	810	60
		$\sum f = 60$	$\sum fx = 2767$	

f $\bar{x} = 46.11\dot{6}$

g The modal class is [47−69] because this class has the highest frequency (21) of any class.

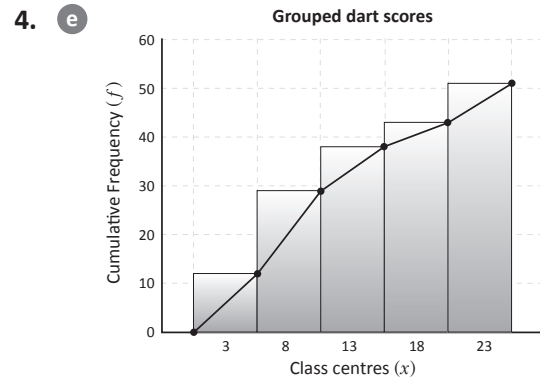**h** The median class is [47−69] because this class contains the 30 and 31 values.

4. **a**

Class	Class Centre (x)	f	fx	cf
1−5	3	12	36	12
6−10	8	17	136	29
11−15	13	9	117	38
16−20	18	5	90	43
21−25	23	8	184	51
		$\Sigma f = 51$	$\Sigma fx = 563$	

b $\bar{x} \approx 11.04$

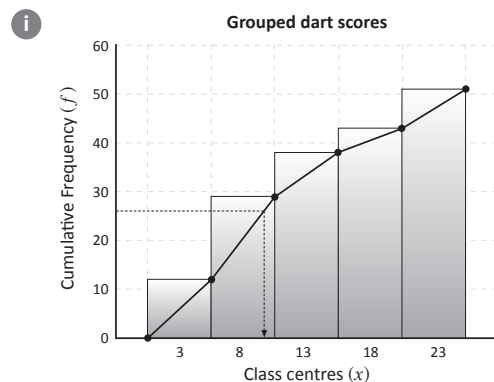**c** [6−10] is the modal class, as it has the highest frequency (17)

d

Grouped dart scores

Thinking More:

4. **e**

Grouped dart scores
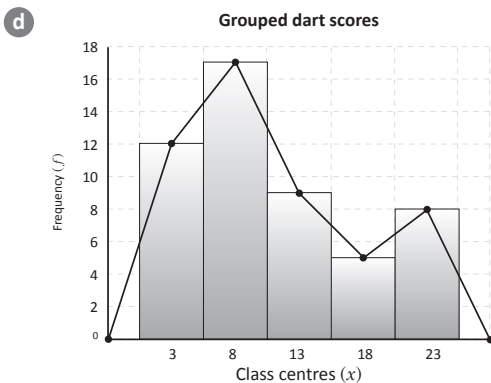
f The total numnber of scores is 51

g The median is at position 26.

h

Grouped dart scores
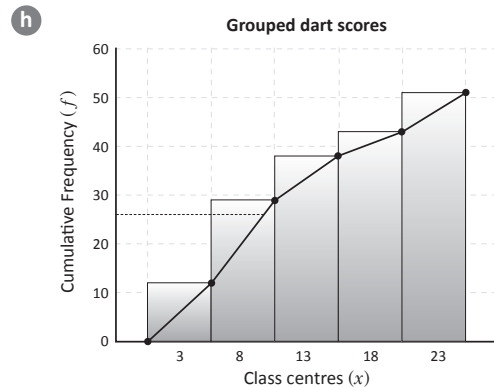
The median class is the second, $6 − 10$.

i

Grouped dart scores

9 or 10 would be good estimates for the median

Mathletics