



# Sampling, frequency polygons, cumulative frequency, box plots and histograms

Grades 4–9 About 85 minutes

Calculator allowed 90 marks

Name \_\_\_\_\_

Class \_\_\_\_\_

Date \_\_\_\_\_

## **A** Before you start

Grades 4–5

You will need these in every question below.

**A1** Write down the midpoint of the class  $25 < t \leq 40$ .

[1 mark]

Answer .....

**A2** Write 54 out of 360 as a fraction in its simplest form.

[1 mark]

Answer .....

**A3** Find the median of 11, 4, 9, 15, 7, 12.

[2 marks]

Answer .....

**A4** A bar is 6 units wide and has an area of 42 square units. Work out its height.

[1 mark]

Answer .....

**A5** The frequencies of four classes are 5, 12, 9 and 4. Write down the running totals.

[1 mark]

Answer .....

**B Examples, then your turn**

Grades 5–6

Your teacher works through each example with you. Then try the one beside it on your own.

**EXAMPLE 1**

A school has 1200 students. 270 of them are in Year 7. A stratified sample of 80 students is taken by year group. How many Year 7 students are in the sample?

**Hint** Year 7 is  $\frac{270}{1200}$  of the school, so it is the same fraction of the sample.

**B1** A club has 900 members. 315 of them are juniors. A stratified sample of 60 members is taken. How many juniors are in the sample? [2 marks]

Answer .....

**EXAMPLE 2**

On a histogram, the bar for the class  $20 < t \leq 45$  has a frequency density of 1.6. How many people are in this class?

**Hint** Frequency is frequency density times class width. The width here is  $45 - 20$ .

**B2** On a histogram, the bar for the class  $30 < m \leq 50$  has a frequency density of 2.4. How many people are in this class? [2 marks]

Answer .....

**EXAMPLE 3**

Find the median and the interquartile range of these 11 values.

3, 5, 6, 8, 9, 11, 12, 14, 15, 18, 21

**Hint** With 11 values the median is the 6th, the lower quartile the 3rd and the upper quartile the 9th.

- B3** Find the median and the interquartile range of these 15 values. [3 marks]  
21, 24, 25, 27, 30, 31, 33, 34, 36, 38, 40, 41, 45, 47, 52

Answer median = ..... , IQR = .....

**EXAMPLE 4**

The times of 30 runners are grouped: 4 in  $0 < t \leq 10$ , 9 in  $10 < t \leq 20$ , 12 in  $20 < t \leq 30$  and 5 in  $30 < t \leq 40$ . Work out an estimate of the mean time.

**Hint** Use the midpoint of each class for every runner in it. Multiply, add, then divide by 30.

- B4** The waiting times of 40 people are grouped: 6 in  $0 < m \leq 20$ , 13 in  $20 < m \leq 40$ , 16 in  $40 < m \leq 60$  and 5 in  $60 < m \leq 80$ . Work out an estimate of the mean waiting time. [3 marks]

Answer .....

Each question asks for something different. Show your working.

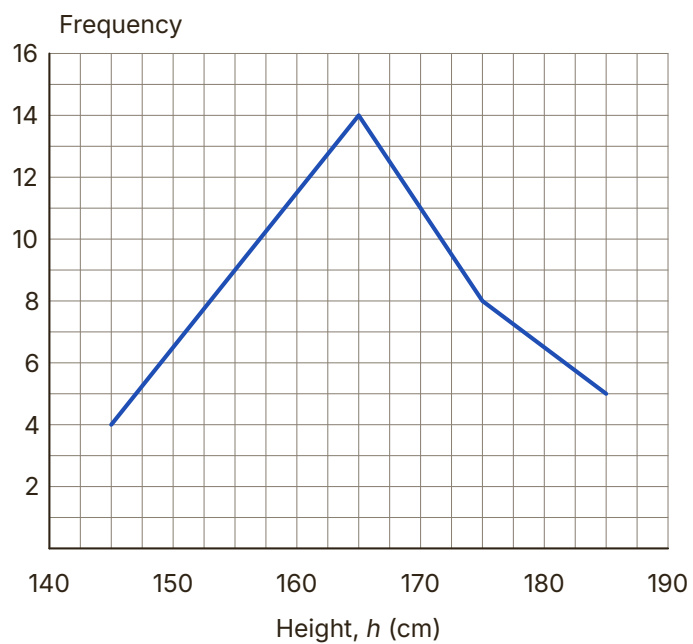
- C1** The table shows the number of students in each year group at a school. A stratified sample of 60 students is taken by year group. How many Year 8 students should be in the sample? [2 marks]

| Year group | Number of students |
|------------|--------------------|
| Year 7     | 285                |
| Year 8     | 345                |
| Year 9     | 270                |

Answer .....

- C2** Ella wants to find out how often the students in her school use the library. She asks 30 students who are in the library at lunchtime. Give two reasons why her sample may be biased. [2 marks]

**C3** The frequency polygon shows the heights of a group of students.



**(a)** How many students are in the group?

[1 mark]

Answer .....

**(b)** Write down the modal class.

[1 mark]

Answer .....

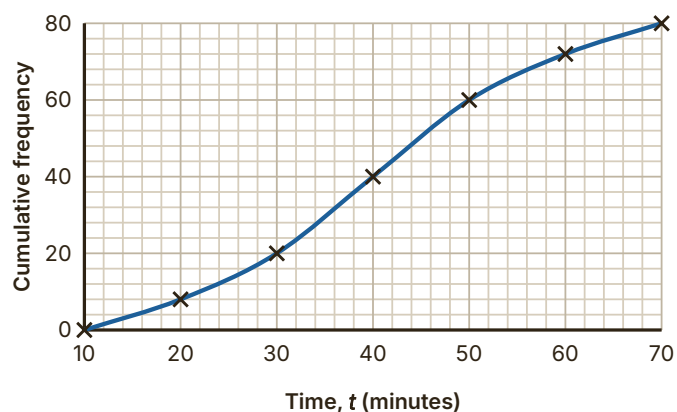
**(c)** Work out an estimate of the mean height.

[3 marks]

Answer .....

**Total for C3: 5 marks**

**C4** The cumulative frequency graph shows the times taken by 80 people to finish a puzzle.



(a) Use the graph to find the median time.

[1 mark]

Answer .....

(b) Use the graph to find the interquartile range.

[2 marks]

Answer .....

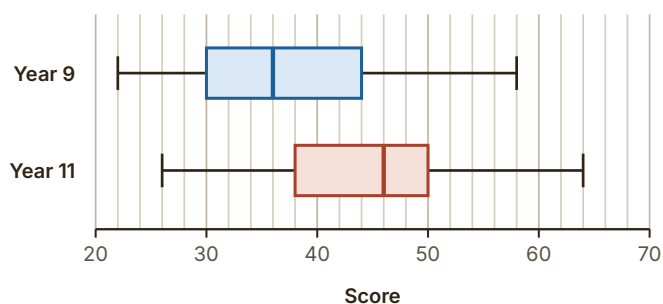
(c) How many people took more than 30 minutes but no more than 60 minutes?

[2 marks]

Answer .....

**Total for C4: 5 marks**

**C5** The box plots show the test scores of a Year 9 group and a Year 11 group.



(a) Write down the median score of the Year 11 group.

[1 mark]

Answer .....

(b) Work out the interquartile range of each group.

[2 marks]

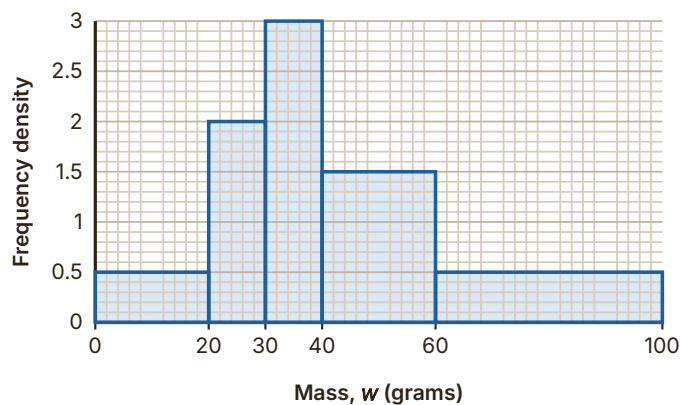
Answer Year 9 ..... Year 11 .....

(c) Compare the scores of the two groups.

[2 marks]

Total for C5: 5 marks

**C6** The histogram shows the masses of some apples.



(a) How many apples have a mass of more than 40 grams?

[2 marks]

Answer .....

(b) Work out an estimate of the number of apples with a mass between 25 grams and 50 grams.

[3 marks]

Answer .....

Total for C6: 5 marks

- C7** The table shows the times some students took to solve a puzzle. Write down the coordinates of the points you would plot to draw a frequency polygon. [2 marks]

| Time, $t$ (minutes) | Frequency |
|---------------------|-----------|
| $0 < t \leq 4$      | 3         |
| $4 < t \leq 8$      | 7         |
| $8 < t \leq 12$     | 12        |
| $12 < t \leq 16$    | 6         |

Answer .....

- C8** The table shows the heights of some plants. Which class contains the median height? [2 marks]

| Height, $h$ (cm)   | Frequency |
|--------------------|-----------|
| $150 < h \leq 160$ | 7         |
| $160 < h \leq 170$ | 15        |
| $170 < h \leq 180$ | 11        |
| $180 < h \leq 190$ | 4         |

Answer .....

- C9** A gym has 800 members. Describe how to take a simple random sample of 50 members. [2 marks]

Answer every question in the space given. Show your working: most of the marks are for method.

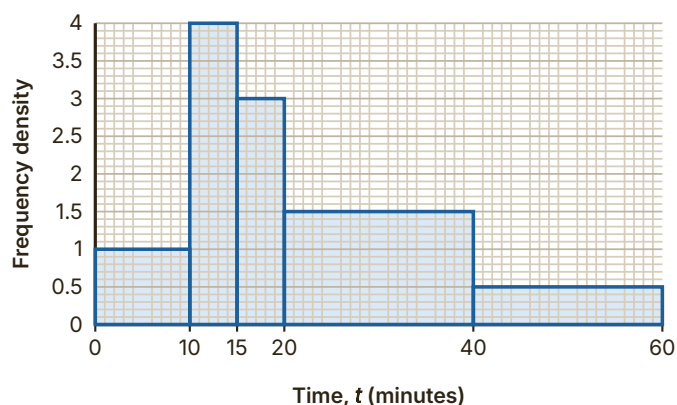
- D1** The table shows the number of students in Year 10 and Year 11 at a school. A sample of 60 students is taken, stratified by year group and by gender. Work out the number of Year 11 girls in the sample. [3 marks]

|         | Boys | Girls |
|---------|------|-------|
| Year 10 | 126  | 144   |
| Year 11 | 117  | 153   |

Answer .....

- D2** Jo says, "More people took between 10 and 15 minutes than in any other class, because that bar is the tallest." [3 marks]

The histogram shows the times some people took to get to work. Is Jo right? You must show your working.

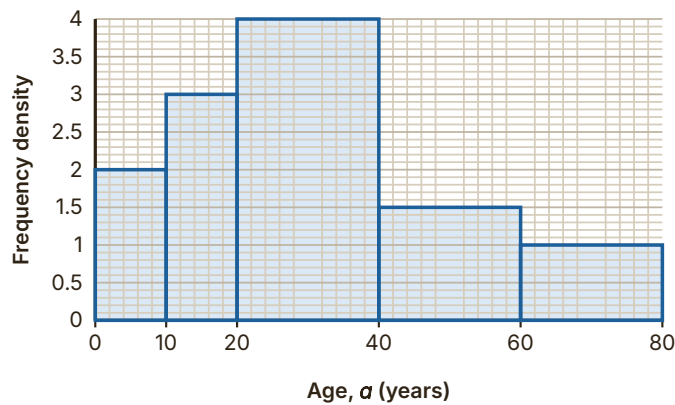


Answer .....

**D3** On a histogram, the bar for the class  $10 < x \leq 20$  has a height of 3.6 and stands for 36 [2 marks]  
people. The class  $20 < x \leq 50$  has 54 people. Work out the height of its bar.

Answer .....

**D4** The histogram shows the ages of the people at a concert. Some of the frequencies are missing from the table.



**(a)** Use the histogram to work out the three missing frequencies in the table. [2 marks]

| Age, $a$ (years) | Frequency |
|------------------|-----------|
| $0 < a \leq 10$  | ?         |
| $10 < a \leq 20$ | 30        |
| $20 < a \leq 40$ | ?         |
| $40 < a \leq 60$ | 30        |
| $60 < a \leq 80$ | ?         |

Answer .....

**(b)** Work out an estimate of the number of people aged between 15 and 50. [2 marks]

Answer .....

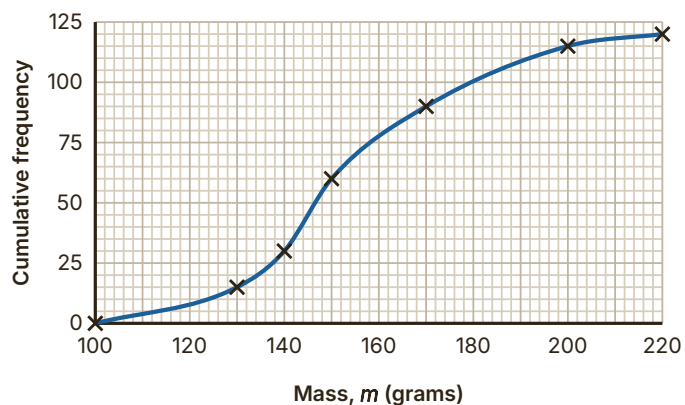
(c) Work out an estimate of the median age.

[2 marks]

Answer .....

Total for D4: 6 marks

- D5** The cumulative frequency graph shows the masses of 120 tomatoes. The lightest tomato has a mass of 104 grams and the heaviest has a mass of 212 grams.



- (a) Use the graph to find the interquartile range.

[2 marks]

Answer .....

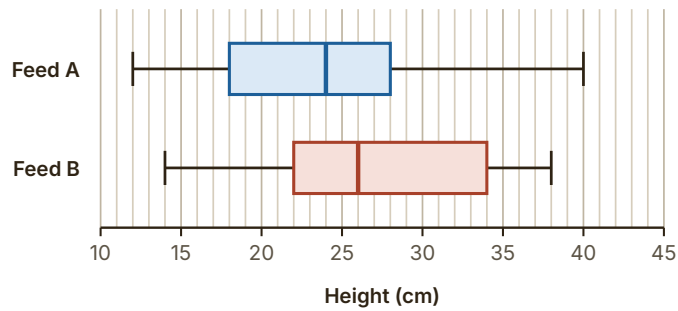
- (b) Draw a box plot for this information. Write the five values you use.

[2 marks]

Answer .....

Total for D5: 4 marks

- D6** Two groups of seedlings were given different feeds. The box plots show their heights after four weeks. Compare the heights of the two groups. [2 marks]



- D7** A company has 2400 workers. 1680 work in an office and the rest work in a factory. Ana takes a stratified sample of 50 workers.

(a) How many factory workers should be in her sample? [2 marks]

Answer .....

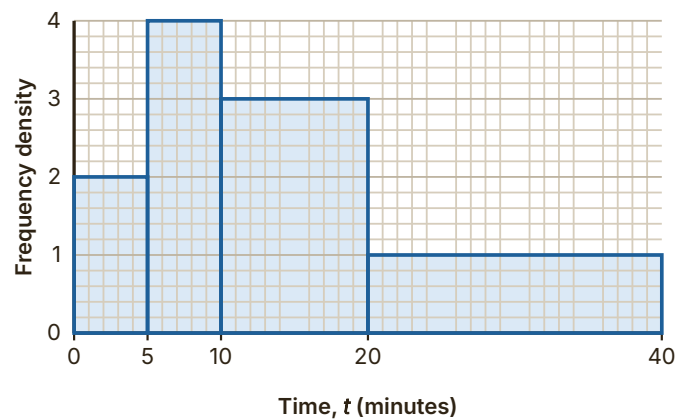
(b) Explain why a stratified sample is better than asking the first 50 workers who arrive in the morning. [1 mark]

Total for D7: 3 marks

D8

The histogram shows the times some customers waited at a counter. Work out an estimate of the mean waiting time. Give your answer to 1 decimal place.

[4 marks]



Answer .....

D9

The table shows the masses of some dogs. Work out an estimate of the number of dogs with a mass of more than 35 kg.

[2 marks]

| Mass, $w$ (kg)   | Frequency |
|------------------|-----------|
| $0 < w \leq 20$  | 14        |
| $20 < w \leq 50$ | 36        |
| $50 < w \leq 60$ | 10        |

Answer .....

D10

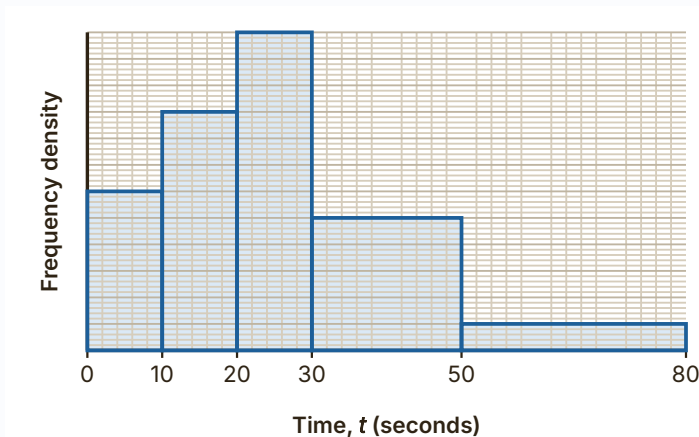
In a stratified sample of 50 students from a school, 14 were in Year 10. There are 182 Year 10 students in the school. Work out the number of students in the school.

[3 marks]

Answer .....

No route is given. Spend five minutes on a problem before you look at a hint. The hints are on the last page of the worksheet, and you can use one at a time.

- E1** The histogram shows the times some people took to answer a quiz question. There is no scale on the frequency density axis. 18 people took between 10 and 20 seconds. How many people are shown on the histogram? [4 marks]



Answer .....

- E2** Some people were timed. 5 took  $0 < t \leq 10$  minutes,  $x$  took  $10 < t \leq 20$ , 12 took  $20 < t \leq 30$  and 3 took  $30 < t \leq 40$ . The estimate of the mean time is 20 minutes. Work out the value of  $x$ . [4 marks]

Answer  $x = \dots\dots$

**E3** Seven whole numbers, in order, are

[4 marks]

2,  $a$ , 6, 8,  $b$ , 15,  $c$

The interquartile range is 10, the range is 16 and the mean is 9. Find  $a$ ,  $b$  and  $c$ .

Answer .....

### **F** How did it go?

Colour one circle on each line.

|                                                                                                                  | Not yet               | Nearly                | Yes                   |
|------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|
| I can take a simple random or a stratified sample, and say why a sample may be biased.                           | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can draw and read a frequency polygon, and estimate a mean from grouped data.                                  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can read the median and quartiles off a cumulative frequency graph, draw a box plot and compare two box plots. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can work out and use frequency density, and estimate from a histogram.                                         | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

## Extension hints

Use one hint at a time. Cover the ones below it with a sheet of paper.

---

- E1**
- Hint 1** Count small squares. The  $10 < t \leq 20$  bar stands for 18 people, so work out how many people one small square stands for.
- Hint 2** Find the area of every bar in small squares, then compare each with the  $10 < t \leq 20$  bar.
- Hint 3** The bars have frequencies in the ratio  $12 : 18 : 24 : 20 : 6$ , so the total is  $12 + 18 + 24 + 20 + 6 = 80$ .
- 
- E2**
- Hint 1** Write the estimate of the mean as a fraction in terms of  $x$ , using the midpoints.
- Hint 2** 
$$\frac{25 + 15x + 300 + 105}{20 + x} = 20$$
- Hint 3**  $430 + 15x = 400 + 20x$ , so  $5x = 30$  and  $x = 6$ .
- 
- E3**
- Hint 1** With seven values the lower quartile is the 2nd and the upper quartile is the 6th.
- Hint 2**  $15 - a = 10$  and  $c - 2 = 16$ .
- Hint 3**  $a = 5$  and  $c = 18$ , then  $2 + 5 + 6 + 8 + b + 15 + 18 = 63$ , so  $b = 9$ .