

Sampling and Populations

Solutions

For Pearson Edexcel GCSE Mathematics (1MA1) • Higher tier

Each question is shown in grey, followed by the working, one step per line. The final answer is in a box. *Marks* shows how the marks are usually given in the exam, and **Tip** points out a common mistake.

1 (4 marks)

Sophie wants to find out how the 900 students at her school travel to school.

- (a) Sophie asks the first 30 students to arrive at school one morning.
Explain why her sample might be biased.

The first students to arrive may all travel in a similar way.

For example, they may come by car or by an early bus, or live close by.

So they may not represent how all the students travel.

Answer: Early arrivals may not travel in the same way as other students

Tip: Explain why **this** sample is not like the whole school. “The sample is too small” is not a reason for bias.

- (b) Sophie then takes a random sample of 30 students.
12 of these students walk to school.
Work out an estimate for the number of students at the school who walk to school.

Fraction of the sample who walk: $\frac{12}{30}$

Use the same fraction of all 900 students:

$$\frac{12}{30} \times 900 = 360$$

Answer: 360

Marks: 1 mark for $\frac{12}{30} \times 900$ or $900 \div 30 = 30$. 1 mark for 360.

- (c) Sophie wants a more reliable estimate.
She is going to take a new random sample of n students from the school.
Write down an inequality for n .

A larger random sample gives a more reliable estimate.

So the new sample must have more than 30 students.

It cannot have more than the 900 students at the school.

Answer: $30 < n \leq 900$ (or $n > 30$)

Tip: “ n is bigger” is not enough. Say what n must be bigger than: the size of the first sample, 30.

2 (3 marks)

750 students eat lunch in a school canteen on Fridays.

Each student chooses one main meal.

The canteen takes a sample of students.

Each student in the sample is asked which main meal they will choose next Friday.

The table shows information about the results.

Main meal	Number of students
pasta	24
curry	14
jacket potato	10
salad	12

- (a) Work out an estimate for the number of portions of pasta the canteen should make.

Sample size: $24 + 14 + 10 + 12 = 60$

Fraction of the sample choosing pasta: $\frac{24}{60}$

$$\frac{24}{60} \times 750 = 300$$

Answer: 300

Tip: Add up the table to find the sample size (60) first.

Marks: 1 mark for $\frac{24}{60} \times 750$ (or $750 \div 60 = 12.5$). 1 mark for 300.

- (b) The canteen manager finds out that the sample was taken only from Year 7 students.

Explain how this could affect your answer to part (a).

The sample may not be representative of all the students who eat lunch on Fridays.

Year 7 students may like pasta more (or less) than older students.

So the estimate of 300 could be too high (or too low).

Answer: Sample may not represent all students, so 300 could be too high or too low

Tip: Say **how** the answer could be affected: the estimate could be too high or too low, because Year 7 may not choose like the whole school.

3 (3 marks)

Leon and Kaya each want to estimate the proportion of people in a town who own a dog.

Leon asks 20 people. 6 of them own a dog.

Kaya asks a random sample of 250 people. 70 of them own a dog.

- (a) Whose results are likely to give the better estimate?
Give a reason for your answer.

Kaya's results.

Her sample is much larger (250 people rather than 20), and it is random.

Answer: Kaya, larger sample

- (b) There are 16 000 people in the town.

Use Kaya's results to work out an estimate for the number of people in the town who own a dog.

Fraction of Kaya's sample who own a dog: $\frac{70}{250}$

$$\frac{70}{250} \times 16\,000 = 4480$$

Answer: 4480

Marks: 1 mark for $\frac{70}{250} \times 16\,000$. 1 mark for 4480.

4 (4 marks)

Jo wants to find out how much exercise people in her town do.
She asks 50 people outside a sports centre.

- (a) Explain why Jo's sample might be biased.

She only asks people outside a sports centre.

These people are likely to exercise more than other people in the town.

Answer: Only people at the sports centre

- (b) Jo then takes a random sample of 80 adults from the whole town.
26 of them say they exercise at least three times a week.
Her friend Amir takes a different random sample of 40 adults from the town.
10 of them say they exercise at least three times a week.

Amir says,

"Our results are different, so one of us must have made a mistake."

Explain why Amir is not correct.

Jo and Amir asked different people.

Two random samples from the same town will usually give different results, just by chance.

So different results do not mean that anyone made a mistake.

Answer: Different random samples contain different people, so the results will usually be different

Tip: Random samples vary. Say that the samples are **different people**, not just that “they asked different numbers of people”.

- (c) Use all the results from both random samples to work out an estimate for the percentage of adults in the town who exercise at least three times a week.

Total number of adults in the two samples: $80 + 40 = 120$

Total number who exercise at least three times a week: $26 + 10 = 36$

$$\frac{36}{120} \times 100 = 30$$

Answer: 30%

Tip: Do not find the mean of the two percentages (32.5% and 25%). The samples are different sizes, so add the numbers of people first: $\frac{36}{120}$.

Marks: 1 mark for $\frac{36}{120}$ or $\frac{26+10}{80+40}$. 1 mark for 30.

5 (4 marks)

A garden centre sells three types of plant: roses, lilies and ferns.

Each week Jess takes a sample of 25 plants to check.

The proportion of each type of plant in her sample is the same as the proportion of that type of plant in the garden centre.

- (a) One week there are 400 plants in the garden centre.

144 of these plants are roses.

Work out the number of roses in Jess's sample that week.

Fraction of the plants that are roses: $\frac{144}{400}$

Number of roses in the sample: $\frac{144}{400} \times 25 = 9$

Answer: 9

Marks: 1 mark for $\frac{144}{400} \times 25$ (or $400 \div 25 = 16$). 1 mark for 9.

- (b) The next week there are 500 plants in the garden centre.
The number of lilies in Jess's sample is 7, correct to the nearest whole number.
Work out the least possible number of lilies in the garden centre that week.

7 to the nearest whole number means the exact value is at least 6.5

Number of lilies in the sample = $\frac{L}{500} \times 25 = \frac{L}{20}$, where L is the number of lilies.

$$\frac{L}{20} \geq 6.5$$

$$L \geq 6.5 \times 20 = 130$$

Check: $\frac{130}{20} = 6.5$, which rounds to 7 ✓

Answer: 130

Tip: The lower bound of 7 (to the nearest whole number) is 6.5, not 6.

Marks: 1 mark for using 6.5. 1 mark for 130.

6 (4 marks)

A factory makes 12 000 light bulbs each day.
A random sample of 150 bulbs is tested.
4 of the bulbs in the sample are faulty.

- (a) Work out an estimate for the number of faulty bulbs made each day.

Fraction of the sample that are faulty: $\frac{4}{150}$

$$\frac{4}{150} \times 12\,000 = 320$$

Answer: 320

Marks: 1 mark for $\frac{4}{150} \times 12\,000$. 1 mark for 320.

- (b) State one assumption you made in working out your answer to part (a).

In part (a), the fraction faulty in the sample, $\frac{4}{150}$, was used for all 12 000 bulbs.

So the assumption is that the sample is representative of all the bulbs made each day.

(Or: the same proportion of bulbs is faulty every day.)

Answer: The sample is representative of all the bulbs made each day (same proportion faulty every day)

Tip: State the assumption, do not describe your method. “I multiplied $\frac{4}{150}$ by 12 000” is not an assumption.

(c) The manager says,

“Less than 2% of our bulbs are faulty.”

Does the sample support what the manager says?

You must show how you get your answer.

Percentage faulty in the sample: $\frac{4}{150} \times 100 = 2.67\%$ (2 d.p.)

2.67% is more than 2%.

So the sample does not support what the manager says.

Answer: No, 2.67% of the sample are faulty