Non-random sampling and types of data

95 marks

Hints online, answers free with an account: mathswariz.uk/worksheets/a-level-statistics-non-random-sampling-types-of-data/

Date

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A Do Now

Quick questions to start. Some use GCSE skills or an earlier lesson; some set slips that the examiner reports say cost marks.

A1 Needed today [2 marks]

A school has 252 boys and 168 girls. A stratified sample of 30 pupils is taken by gender. Find the number of boys and the number of girls in the sample.

Answer .....

A2 Needed today [2 marks]

For a car, say whether each of these is qualitative or quantitative: (i) its colour, (ii) its number of doors, (iii) its mass.

Answer .....

A3 Needed today [2 marks]

A class in a frequency table is $20 \leq t < 35$. Write down its class width and its midpoint.

Answer .....

A4 Needed today [2 marks]

Estimate the mean of the data in the table.

x	Frequency
$0 \leq x < 10$	4
$10 \leq x < 20$	10
$20 \leq x < 30$	6

Answer .....

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A5 Common slip [2 marks]

A length is recorded as 7.4 cm, to 1 decimal place. Write down the smallest length it could be, and the length it must be less than.

Answer .....

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PART 1 Quota and opportunity samples

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EXAMPLE 1 · I DO

A market researcher wants the views of 80 adults who shop in a town centre. In the town, 45% of adults are aged 18 to 39, 35% are aged 40 to 59 and 20% are aged 60 or over. She uses a quota sample.

(a) Find the quota for each age group.

(b) Describe how she would take the quota sample.

(c) Give one advantage and one disadvantage of quota sampling for this survey.

Hint A quota sample splits the population into groups in the same way as a stratified sample, but the interviewer picks people, so it is not random. It needs no sampling frame.

YOUR TURN · WE DO

B1 A council wants the views of 60 drivers about a new car park. Of the cars in the town, 15% are electric, 60% are petrol and 25% are diesel. It uses a quota sample by type of car.

(a) Find the quota for each type of car. [2 marks]

Answer .....

(b) Describe how the council could take the quota sample. [2 marks]

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(c) Give one disadvantage of this method for this survey. [1 mark]

Total for B1: 5 marks

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EXAMPLE 2 · I DO

A swimming coach wants the mean time for 100 m of the 12 swimmers in a squad. To save time he records the times of the first 4 swimmers to arrive at training: swimmers A, B, C and D. Later he records all 12 times, shown in the table.

(a) Name the sampling method he used first, and give one advantage of it.

(b) Find the mean of his sample of 4 and the mean of all 12 times.

(c) Explain why the first 4 swimmers to arrive could give a biased estimate.

Swimmer	Time (s)
A	38
B	41
C	35
D	44
E	52
F	47
G	39
H	55
I	49
J	43
K	58
L	51

Hint An opportunity sample uses the people who are available at the time. It is quick, but the people who are available may differ from the rest, so it can be biased.

YOUR TURN · WE DO

B2 A running club has 10 members. The coach wants the mean time for a 400 m run. She times the first 4 members to arrive, pupils 1 to 4. Later she times every member. The table shows all 10 times.

Pupil	Time (s)
1	84
2	92
3	77
4	105
5	131
6	148
7	96
8	88
9	101
10	79

(a) Name the sampling method she used first. [1 mark]

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(b) Find the mean time of her first sample, and the mean time of all 10 members. [3 marks]

Answer .....

(c) Give a reason, in context, why her first sample gave a mean that was too low. [1 mark]

Total for B2: 5 marks

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C1 An exam question said: "A newspaper uses a quota sample to find out what 100 readers think of its website. Give one disadvantage of this method." Three students answered: [4 marks]

Ana: "A quota sample needs a sampling frame, and there is no list of readers."

Ben: "It is quicker and cheaper than other methods."

Cal: "The interviewer chooses which readers to ask, so the sample is not random and could be biased, for example towards readers who reply to emails."

Say which answer earns the mark, and explain what is wrong with each of the other two.

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C2 Asha studies the newts in a pond. She catches newts until she has 10 males and 10 females, then measures them. She says: "This is a stratified sample by gender." The pond has about twice as many females as males. Explain why her sample is a quota sample, not a stratified sample, and say how a stratified sample of 20 would be different. [4 marks]

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PART 2 Naming the method and the type of data

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EXAMPLE 3 · I DO

(a) Name the sampling method in each case.

(i) A toll booth records the type of every 10th car, starting with a car chosen at random from the first 10.

(ii) A reporter asks the first 20 people who leave a station what they think of a new timetable.

(iii) A researcher is told to interview 30 men and 30 women in a shopping centre, and chooses who to ask.

(iv) A list of 500 members is numbered and a random number generator picks 25 different numbers.

(b) Give two ways in which a quota sample is different from a stratified sample.

Hint Ask two questions: are the members chosen at random? Is there a list to choose from? Random with a list: simple random, systematic, stratified. Chosen by the interviewer: quota or opportunity.

YOUR TURN · WE DO

B3 Read each description.

(i) A vet asks the owners who come into the surgery on Tuesday morning about their pets' diet.

(ii) A college lists its 1200 students by year group and takes a random sample from each year in proportion to its size.

(iii) An interviewer in a shopping centre is told to ask 25 people under 30 and 25 people aged 30 or over, and chooses who to ask.

(a) Name the sampling method in each case. [3 marks]

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(b) For (iii), give one reason why a quota sample was used instead of a stratified sample. [1 mark]

Total for B3: 4 marks

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EXAMPLE 4 · I DO

Say whether each variable is qualitative or quantitative. For a quantitative variable, say whether it is discrete or continuous. Give a reason each time.

(i) The number of goals scored in a football match.

(ii) The time taken to run 100 m.

(iii) Hair colour.

(iv) UK shoe size.

(v) A wind description from the Beaufort scale: "Light", "Moderate", "Fresh".

Hint Qualitative data are words or categories. Quantitative data are numbers. Discrete: only certain values. Continuous: any value in a range. Decimals do not make data continuous: shoe size has halves but is still discrete.

YOUR TURN · WE DO

B4 Say whether each variable is qualitative or quantitative. For a quantitative variable, say whether it is discrete or continuous.

(i) The number of people in a car.

(ii) The mass of a parcel.

(iii) Favourite fruit.

(iv) The temperature at noon, in °C.

(v) Cloud cover, recorded in oktas (eighths of the sky covered): a whole number from 0 to 8.

(a) Classify (i) to (iv). [4 marks]

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(b) Classify (v), with a reason. [1 mark]

PRACTICE · YOU DO

C3 Name the sampling method in each case. [4 marks]

(i) A gardener weighs the first 15 tomatoes she picks from a greenhouse of 200 plants.

(ii) A gym numbers its 800 members, chooses a random start from 1 to 20, then takes every 20th member.

Total for B4: 5 marks

(iii) A survey team is told to interview 40 men and 40 women at a railway station, and chooses who to ask.

(iv) For (iii), give a reason in context why the sample may be biased.

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C4 Each statement below is wrong. Explain why, and correct it. [6 marks]

(i) "Shoe size is continuous, because feet can be any length."

(ii) "A wind description on the Beaufort scale ("Light", "Moderate", "Fresh") is discrete data."

(iii) "The number of cars per household is continuous, because the mean is 1.4."

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PART 3 Class boundaries and midpoints

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EXAMPLE 5 · I DO

(a) Times are recorded to the nearest minute. Write down the class boundaries, width and midpoint of the class 15–19.
(b) The ages, in whole years, of 30 people are shown in the table. Write down the class boundaries of the class 20–34.
(c) Estimate the mean age of the 30 people.

Age (years)	Frequency
10–14	5
15–19	9
20–34	12
35–49	4

Hint Rounded data: the boundaries are half a unit either side. Ages in whole years: someone aged 14 can be up to 15, so the class 10–14 is $10 \leq \text{age} < 15$. The midpoint is halfway between the boundaries.

YOUR TURN · WE DO

B5 The times taken by 40 people to finish a puzzle were recorded to the nearest minute. The table shows the results.

Time (min)	Frequency
10–14	6
15–19	11
20–29	15
30–49	8

(a) Write down the class boundaries and the width of the class 20–29. [2 marks]

Answer .....

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(b) Estimate the mean time. [3 marks]

PRACTICE · YOU DO

C5 The masses of some apples are recorded to the nearest 10 g. One class in a table is 150–190 g, which contains the recorded values $150, 160, 170, 180$ and 190. Kai says the class width is 40 g. Explain his mistake, and find the class boundaries, the width and the midpoint of the class. [4 marks]

Answer .....

Total for B5: 5 marks

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C6 The table shows the ages, in whole years, of 60 people at a concert. Dev estimates the mean age using the midpoints 16.5, 21 and 34.5. Explain Dev's mistake, and estimate the mean age correctly. [6 marks]

Age (years)	Frequency
16–17	12
18–24	30
25–44	18

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C7 The table shows the ages, in whole years, of the people at a gym class. One frequency, k, is missing. Using the class midpoints, an estimate of the mean age of the people in the class is exactly 25 years. Find the value of k. [6 marks]

Age (years)	Frequency
10–15	8
16–19	k
20–29	24
30–49	12

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D1

> Jade says: "The mean for my sample is 7.5 hours, so the mean for the school must be 7.5 hours."

Jade wants the mean number of hours of homework done last week by the 960 pupils in her school. She asks 12 of her friends. Their answers, in hours, are

$$6,\ 8,\ 5,\ 9,\ 7,\ 6,\ 10,\ 8,\ 7,\ 9,\ 6,\ 9$$

(a) Name the sampling method Jade used and show that the mean of her sample is 7.5 hours. [3 marks]

Answer .....

(b) Explain why Jade's claim may be wrong. [2 marks]

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(c) There are 192 pupils in each of the five year groups. Find how many pupils from each year group should be in a stratified sample of 40, and describe how the pupils from Year 9 would be chosen. [4 marks]

Total for D1: 9 marks

D2 The lengths of 40 fish caught in a river were measured to the nearest cm. The results are shown in the table.

Length (cm)	Frequency
20–24	8
25–29	14
30–39	13
40–59	5

(a) State, with a reason, the type of data, and give a reason why the data are shown grouped. [2 marks]

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(b) Write down the class boundaries and the width of the class 30 –39. [2 marks]

Answer .....

(c) Estimate the mean length of the fish. [4 marks]

Answer .....

(d) Explain why your answer to (c) is an estimate. [2 marks]

Total for D2: 10 marks

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E Extension

Stretch

No route is given. The hints are at the end of the sheet. Use one at a time.

E1 A researcher plans a quota sample of the adults in a city by sex and age. In the city, 48% of adults are men and 52% are women. Of the men, 25% are aged 18 to 34, 40% are 35 to 54 and 35% are 55 or over. Of the women, 20% are 18 to 34, 45% are 35 to 54 and 35% are 55 or over. There is one quota for each of the six groups.

(a) The researcher has time for 150 interviews. Find the six quotas, rounding where needed, and check the total. [4 marks]

Answer .....

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(b) Find the smallest sample size for which all six quotas are whole numbers with no rounding, and give the six quotas. [4 marks]

Answer .....

Total for E1: 8 marks

Extension hints

Cover these with paper. Uncover one at a time.

E1

Hint 1 The share of all adults who are men aged 18 to 34 is 0.48×0.25.

Hint 2 When you round the six quotas, add them up to check they still make 150.

Hint 3 Write each share as a fraction in its lowest terms. The sample size must be a multiple of every denominator.

How did it go?

Colour one circle on each line: not yet, nearly, yes.

I can describe how to take a quota sample and an opportunity sample, and work out the quotas.	○ ○ ○
I can give advantages and disadvantages of quota and opportunity sampling in the context of a question.	○ ○ ○
I can say whether data are qualitative or quantitative, and discrete or continuous, with a reason.	○ ○ ○
I can find class boundaries, widths and midpoints, and estimate a mean from grouped data.	○ ○ ○

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