Populations, samples and random sampling

96 marks

Hints online, answers free with an account: mathswariz.uk/worksheets/a-level-statistics-populations-samples-random-sampling/

Date

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

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]

Thirty names are written on identical cards and put in a bag. Four cards are taken out, one at a time, without replacement. Find the probability that Ella's card is one of the four.

Answer .....

A2 Needed today [2 marks]

A town has 2400 adults and 900 of them are over 60. A sample of 40 adults is chosen so that the proportion over 60 is the same as in the town. How many adults over 60 are in the sample?

Answer .....

A3 Needed today [2 marks]

A head teacher asks every one of the 85 teachers in her school for their view on a new timetable. State the population, and name this type of survey.

Answer .....

A4 Common slip [2 marks]

To take a systematic sample of 20 from a list of 400 names, Mo says: "Take every 20th name, starting with the 20th name." Say what is wrong with his method and correct it.

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

PART 1 Populations, censuses and samples

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

EXAMPLE 1 · I DO

A garden centre receives a delivery of 1500 tulip bulbs. It tests whether a bulb grows by planting it in a tray, after which the bulb cannot be sold.

(a) State the population, the sampling unit and a suitable sampling frame.

(b) Give a reason why the garden centre should not test all the bulbs.

(c) A random sample of 20 bulbs is tested and 17 of them grow. Estimate the number of bulbs in the delivery that would grow.

(d) The supplier claims that at least 90% of its bulbs grow. Comment on this claim, and suggest how the garden centre could improve its estimate.

Hint Population: everything of interest. Sampling unit: one member. Sampling frame: a list of the members. Always answer in the context of the question.

YOUR TURN · WE DO

B1 A factory makes a batch of 2000 batteries. A battery's lifetime is found by leaving it on until it is flat. The table shows the lifetimes of a random sample of 8 batteries from the batch.

Battery	Lifetime (h)
1	41
2	38
3	45
4	36
5	44
6	39
7	47
8	42

(a) State the population and the sampling unit. [2 marks]

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(b) Give a reason why the factory should use a sample rather than a census. [1 mark]

(c) The factory claims that the mean lifetime of its batteries is more than 40 hours. Use the sample to comment on this claim. [3 marks]

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

C1 A theatre sold 950 tickets for one performance. After the show the manager asks 40 of the ticket holders whether they enjoyed it.

(a) State the population and the sampling unit.

(b) Suggest a suitable sampling frame.

(c) Give one reason why the manager does not ask every ticket holder.

(d) Suggest one way the factory could improve its estimate of the mean lifetime. [1 mark]

[4 marks]

Total for B1: 7 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

C2 For each survey, state whether a census or a sample should be used, with a reason in context. [6 marks]

(a) A school wants to know which of its 85 staff can come to a training day.

(b) A match maker wants to know how long its matches burn. It makes 3000 matches an hour.

(c) A water company wants the weekly water use of the 2.1 million homes it supplies.

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

PART 2 Simple random and systematic samples

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

EXAMPLE 2 · I DO

A club has 240 members, listed alphabetically.

(a) Explain how the club could use a random number generator to take a simple random sample of 12 members.

(b) Explain how a lottery method could be used instead.

(c) The members are numbered 001 to 240. Here is a row of random digits.

$83024 \quad 11925 \quad 08030 \quad 07119 \quad 21450$

Starting at the left and reading the digits in groups of three, select the first 4 members of the sample.

Hint A simple random sample needs a sampling frame: list and number every member. Ignore numbers outside the list and numbers already used.

YOUR TURN · WE DO

B2 A firm's 650 workers are numbered 001 to 650. Here is a row of random digits.

$71245 \quad 08861 \quad 20918$

$45030 \quad 5446$

(a) Starting at the left and reading the digits in groups of three, select the first 4 workers for a simple random sample. [3 marks]

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(b) Explain how a lottery method could be used to take a simple random sample of 25 of the workers. [2 marks]

Total for B2: 5 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

EXAMPLE 3 · I DO

(a) A list of 1200 voters is in alphabetical order. Describe how to take a systematic sample of 60 voters.

(b) A sports shop records its takings on each of 210 days in a row, starting on a Monday. Explain why a systematic sample that takes every 7th day could give a biased estimate of the mean daily takings.

(c) Explain why a systematic sample is not a simple random sample.

Hint The interval is $k = \dfrac{\text{population size}}{\text{sample size}}$. The start is a random number from 1 to k. A list with a pattern that repeats every k places makes the sample biased.

YOUR TURN · WE DO

B3 A delivery firm logs 960 parcels in the order they arrive. It wants a sample of 40 parcels to check their packaging.

(a) Describe how to take a systematic sample of 40 parcels. [3 marks]

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(b) A hospital's staff list is in teams of 8, and the team leader is always first in the team. Explain why a systematic sample taking every 8th person on this list could be biased. [2 marks]

PRACTICE · YOU DO

C3 A farmer has 400 apple trees, planted in 20 rows of 20. She wants to estimate the mean mass of apples per tree. Describe how she could take a simple random sample of 25 trees. [3 marks]

C4 Owen wants a simple random sample of 10 of the 300 pupils in his year. He asks the first 10 pupils who arrive at school one morning. He says: "Any pupil could have arrived first, so this is a simple random sample." Explain why Owen is wrong, and describe how he could take a simple random sample. [4 marks]

Total for B3: 5 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

C5 Max wants a systematic sample of 25 from a list of 600 workers. He chooses a random number from 1 to 600 for the first worker, and then takes every 25th worker. Find two errors in his method, and describe a correct systematic sample. [4 marks]

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

PART 3 Stratified samples and choosing a method

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

EXAMPLE 4 · I DO

A college has 192 students in Year 12, 144 in Year 13 and 64 adult learners.

(a) The college wants a stratified sample of 50 students by group. Find the number to take from each group.

(b) Explain how the Year 13 students in the sample would be chosen.

(c) Another college takes a stratified sample of 36 students by year. It has 200 students in Year 12 and the sample contains 15 of them. Find the total number of students at this college.

Hint Every stratum is sampled in the same proportion. Check the numbers add up to the sample size. Inside each stratum the members are chosen at random.

YOUR TURN · WE DO

B4 A gym has 600 members. The table shows them by gender and type of membership. The gym takes a stratified sample of 60 members by gender and type.

Members	Full	Off-peak
Male	210	90
Female	180	120

(a) Find the number of members of each kind in the sample. [3 marks]

Answer .....

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(b) Give one advantage of a stratified sample here, in context, and explain how the female off-peak members would be chosen. [2 marks]

EXAMPLE 5 · I DO

A supermarket wants the views of its 2400 staff on a new rota. The staff work as shelf staff, checkout staff or managers, and there are far fewer managers than other staff. Give one advantage and one disadvantage of each of simple random, systematic and stratified sampling here. State which method you would use, with a reason.

Hint A generic answer ("it is cheap", "it may be biased") earns nothing. Say why, using the people or things in the question.

YOUR TURN · WE DO

B5 A council wants the views of the people in four villages on a new road. The villages have 3600, 900, 450 and 150 adults. Give one advantage and one disadvantage of a simple random sample of the adults, in context. State, with a reason, a better method. [4 marks]

Total for B4: 5 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

C6 A youth club has 87 members aged under 14, 152 aged 14 to 16 and 61 aged 17 or over. Lena wants a stratified sample of 40 by age. She says: "There are three groups, so I will take 13 or 14 from each group." Explain why her sample is not a stratified sample, and find the correct numbers. [4 marks]

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

C7 A hospital surveys its 1100 staff, who are doctors, nurses, porters and office staff. Three students give a disadvantage of a stratified sample by job. [4 marks]

Ana: "It may be biased."

Ben: "Each job group needs its own list, and staff who have two jobs, such as a nurse who also works in the office, are hard to place in one group."

Cal: "It takes a long time."

Say which answer earns the mark, and why each of the others does not. Then give an advantage of a stratified sample here.

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

C8 A stratified sample of the nurses at three hospitals, A, B and C, is taken by hospital. The numbers in the sample were not rounded. The sample contains 28 nurses from hospital A, 21 from hospital B and 16 from hospital C. Hospital A has 420 nurses. Find the number of nurses at hospital B and at hospital C, and the size of the sample as a percentage of all the nurses. Describe how the nurses from hospital B were chosen. [6 marks]

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

D1 A town council wants to know how many of the $24\,000$ households in the town would use a new food-waste collection. It has a list of the $21\,600$ households that pay for a garden-waste collection, and it takes a simple random sample of 180 households from this list. Of these, 117 say they would use the new collection.

(a) State the population and the sampling frame used, and explain why this sampling frame is not suitable for this survey. [3 marks]

(b) Give one reason why the council uses a sample rather than a census, and one advantage a census would have. [2 marks]

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(c) Estimate the number of households on the list that would use the new collection. [2 marks]

Answer .....

(d) The council then asks all 2400 households that are not on the list, and 900 of them say they would use the new collection. Estimate the proportion of all the households in the town that would use it, and explain why using 0.65 for the whole town would give an estimate that is too high. [3 marks]

Total for D1: 10 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

D2

> Sanjay says: "My start was chosen at random, so my systematic sample is random and will give a fair estimate of the mean daily takings."

A shop records its takings on each of 182 days in a row, numbered 1 to 182. Day 1 is a Monday. To estimate the mean daily takings, Sanjay takes a systematic sample of 26 days. He chooses a random start from 1 to 7 and then takes every 7th day.

(a) Explain why Sanjay's sample could give a biased estimate. [2 marks]

(b) Sanjay's random start was 6. List the first four days in his sample and say what they have in common. [2 marks]

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

(c) Sanjay decides instead to take every 6th day, from a random start from 1 to 6. Show that, with a start of 1, the first seven days in the sample fall on seven different days of the week, and find how many days the sample contains with a start of 1 and with a start of 6. [4 marks]

Total for D2: 8 marks

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

E Extension

Stretch

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

E1 [9 marks]

A list of 120 people is numbered 1 to 120. A sample of 10 people is to be taken by one of two methods.

Method S: a systematic sample, with a random start from 1 to 12 and then every 12th person.

Method R: a simple random sample.

Show that each method gives every person the same probability of being chosen. For each method, find the probability that persons 7 and 19 are both chosen, and the probability that persons 7 and 8 are both chosen. Use your answers to explain why a systematic sample is not a simple random sample.

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.

Extension hints

Cover these with paper. Uncover one at a time.

E1

Hint 1 In method S, which starts lead to a given person being chosen? Think about remainders on division by 12.

Hint 2 In method R, find the probability that person 7 is chosen, then the probability that person 19 is chosen given that person 7 has been.

Hint 3 Compare the pair probabilities for the two methods. What does the definition of a simple random sample say about every possible sample?

How did it go?

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

I can explain the terms population, census, sample, sampling unit and sampling frame, and say why a census is not always used.	○ ○ ○
I can describe how to take a simple random sample and a systematic sample, and choose a sample from random numbers.	○ ○ ○
I can work out the number to take from each stratum in a stratified sample, and work backwards from a sample.	○ ○ ○
I can give advantages and disadvantages of each random sampling method in the context of a question.	○ ○ ○

© 2026 Mathswariz. All rights reserved. Free for personal and classroom use. Not to be sold or republished.