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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 3 Mathematics and Statistics (Statistics) 2023

91585 Apply probability concepts in solving problems

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Apply probability concepts in solving problems.	Apply probability concepts, using relational thinking, in solving problems.	Apply probability concepts, using extended abstract thinking, in solving problems.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Make sure that you have the Formulae and Tables Booklet L3–STATF.

Show ALL working.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA DO NOT WRITE). This area will be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

QUESTION ONE

(a) Two schools, one in the North Island and one in the South Island, surveyed and combined the data from a group of 157 Year 9, Year 11, and Year 13 students about whether they liked coffee or not.

The table below shows the results of the combined surveys

	Year 9	**Year 11**	**Year 13**
Like coffee	13	11	22
Do not like coffee	43	38	30

(i) Using the results of the survey, calculate the probability of a randomly selected student being in Year 9 or Year 11 if they stated that they do not like coffee.

(ii) Four Year 11 students are randomly chosen from the survey results.

Calculate the probability that at least one of these four students stated that they like coffee.

(iii) State an assumption you made when you calculated your answer to part (ii) and discuss whether (or not) this assumption is likely to be valid.

(iv) It is believed that coffee is more popular as students age.

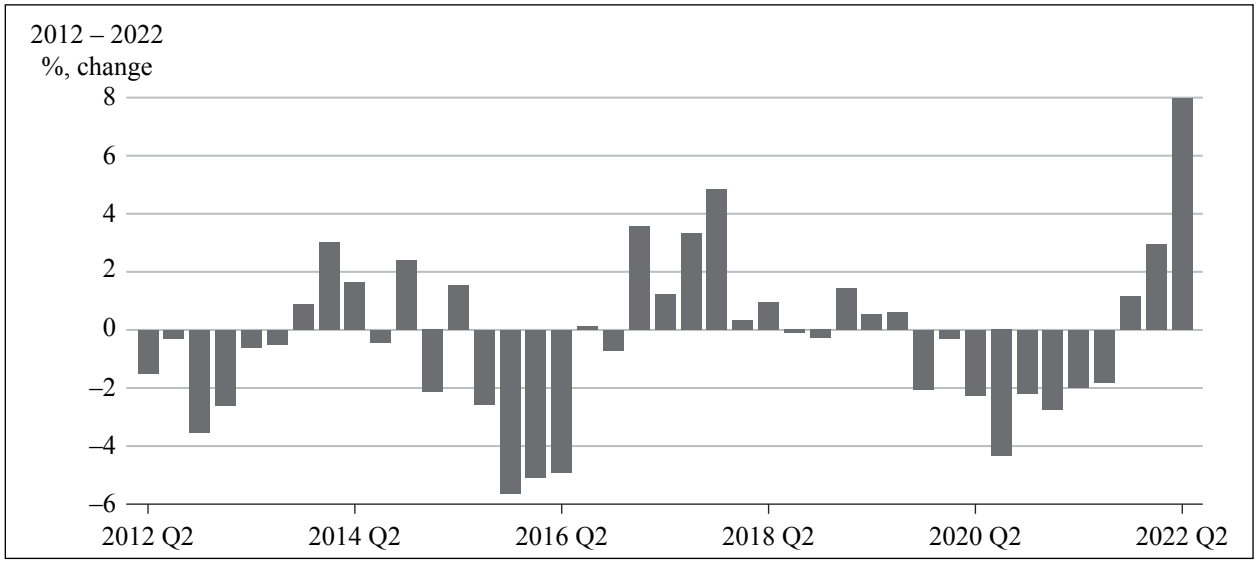
Is this belief correct for this group of students?

Use statistical reasoning in your answer.

(v) Explain how it could be shown that liking or not liking coffee for each of Year 9, Year 11, and Year 13 students from the combined surveys are independent of whether the school is located in the North Island or South Island.

(b) The price of a cup of coffee in New Zealand is measured every quarter (3 month period) by Stats New Zealand | Tautauranga Aotearoa. The visualisation below shows how much the price of coffee has changed in that quarter as a percentage from the previous year, over 10 years from the 2nd quarter of 2012 to the 2nd quarter of 2022. Note – this means there are **41 quarters** included in the graph.

Year-on-year price change in price of coffee in New Zealand



Source: https://figure.nz/chart/0ByKhsHZZX7N8W2x-dkvqiLEp0dslISfY

(i) A statistician has been asked to review a model that claims the probability of the next two successive quarters showing a price increase for a cup of coffee is just under 20%.

Show how this model could have been developed.

(ii) State an assumption that was made when developing this model, and discuss whether (or not) this assumption is likely to be valid.

QUESTION TWO

(a) 510 people who liked coffee from around New Zealand were asked about their preferred coffee. The survey allowed them to select UP TO TWO preferred coffee types: mocha, flat white, or cappuccino.

The results found that:

- 423 preferred at least one of the coffee types offered in the survey
- 81 preferred only cappuccino
- 38 preferred only flat white
- 29 indicated they preferred flat white and mocha
- 103 preferred mocha only
- none of the people surveyed indicated they preferred cappuccino and mocha.

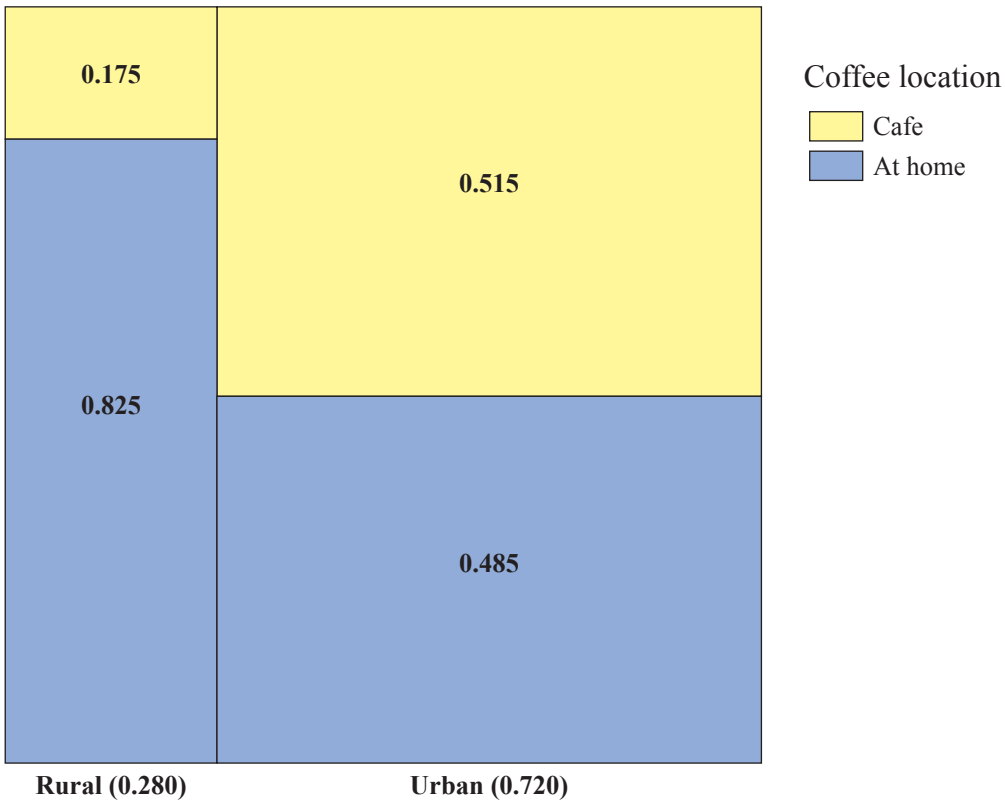
(i) Calculate the proportion of people who indicated they preferred cappuccino.

(ii) A claim is made that it is 50% more likely that those people who preferred cappuccino selected only cappuccino compared to those people who preferred mocha selecting only mocha.

Do the survey results support this claim?

Support your answer with appropriate statistical reasoning.

(b) The eikosogram below illustrates from the 510 people in the survey whether they live in a rural or urban area, and whether they prefer to make their coffee at home or go to a cafe. An eikosogram visually separates the probabilities for two variables into rectangular regions whose areas are in proportion to the probability value.



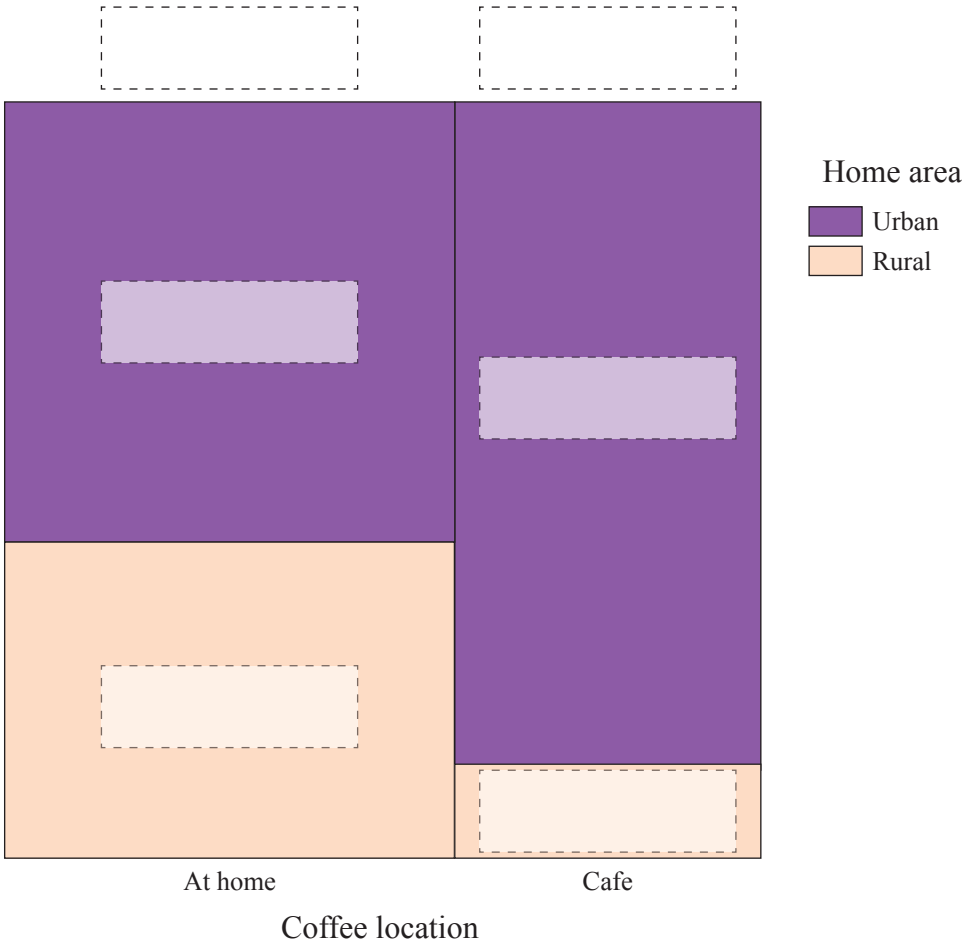
(i) Write down the probability that a person who lives in an urban area would prefer to have their coffee at a cafe.

(ii) What evidence exists from the results of the survey displayed in the eikosogram that there is a difference in preference for having coffee at home or in a cafe between people who live in rural or urban areas?

Support your answer with statistical reasoning, with reference to sampling variation.

(iii) The eikosogram below represents the results from the same survey but with the factors swapped around (**home area** and **coffee location**).

Complete the values in the six boxes to complete the missing information for this Eikosogram.



QUESTION THREE

(a) Three friends meet regularly for coffee. They have been analysing the strengths (extra strong or not extra strong) and brands (Fair Trade brands or not Fair Trade brands) of coffee that they have tried.

Fifteen different brands of coffee were tried and of these, 12 were from Fair Trade brands. Eight of the brands were extra strong strength, of which five were from Fair Trade brands.

Explain if the following events "the coffee is not a Fair Trade brand" and the "coffee is not extra strong" are mutually exclusive.

Give at least one numerical calculation.

(b) The three friends meet for a coffee each in a cafe once a week. They have a system for deciding who will pay for all three coffees which involves each of them flipping a coin. The friend who flips a result different to the other two is considered the "odd one out" and ends up paying for all three coffees.

(i) Calculate the probability that no one is "the odd one out" and the three friends will end up having to flip their coins again.

(ii) Explain, using statistical reasoning, why each friend can expect to pay on the same number of times.

Question Three continues on the next page.

(iii) The friends have met for coffee 100 times over two years. The friends were surprised that during that whole period of time, they have never had to flip their coins more than five times at any meeting, in order to decide who paid.

Explain, using statistical reasoning, if this is an unusual occurrence.

(iv) Friend A has been recording who has been paying for the coffees over the last two years. The results of 100 coffee meet ups are shown in the table below. Friend A thinks that the number of times they have had to pay has been too high.

Number of times each friend ended up paying for coffees

Friend A	Friend B	Friend C
49	23	28

Discuss how carrying out a simulation would help Friend A decide if the proportion of times they have paid for coffee has been too high.

You do not need to design the simulation.

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER