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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Mathematics and Statistics 2024

91267 Apply probability methods in solving problems

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Apply probability methods in solving problems.	Apply probability methods, using relational thinking, in solving problems.	Apply probability methods, 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.

Show ALL working.

Make sure that you have the Formulae Sheet L2–MATHF.

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 2–16 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). 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

Working, including diagrams, should be shown for all parts of Question One.

In a recent survey, Sport New Zealand asked how many hours in the last week that participants had spent being physically active for sport, PE, exercise, or fun.

(a) The results showed that young people (aged 5–17) were involved in physical activity for a mean of 10.8 hours per week, with a standard deviation of 3.2 hours.

Assume that the distribution of weekly physical activity hours for all young people can be approximately modelled by a normal distribution.

(i) Find the probability that a randomly chosen young person spent between 6 and 10.8 hours of physical activity in the last week.

(ii) Find the probability that a randomly chosen young person spent over 16 hours on physical activity in the last week.

(iii) 12% of all young people were found to do less than the suggested amount of physical activity to meet the Ministry of Health guidelines.

What is the minimum number of weekly hours of physical exercise needed to meet the guidelines?

(b) The results of the survey also showed that for Year 11 and 12 students (age 15–17 years), the mean weekly hours spent on physical activity was only 8.1 hours.

5% of students aged 15–17 in the survey spent less than 30 minutes (0.5 hours) on physical activity each week.

(i) Calculate the standard deviation for the number of weekly hours spent on physical activity by students aged 15–17.

(ii) Give TWO reasons why your answer in (b)(i) suggests that a normal distribution may NOT be an appropriate model for the number of hours spent on physical activity for students aged 15–17 years.

(c) Participating in regular physical exercise is one of the best ways to reduce the risk of dementia later in life. The survey also investigated the activity levels of elderly people in New Zealand aged 75 years and over.

45% of survey respondents aged 75 years and over spent less than 30 minutes (0.5 hours) in weekly physical activity, with a mean of 4.3 hours per week.

(i) What does this suggest about the distribution of physical activity hours for people aged 75 and over?

When those adults 75 years and over who spent **no** time in physical activity were excluded, the mean increased to 7.2 hours of physical activity per week and the data looks like this:

Data source: https://sportnz.org.nz/resources/active-nz-survey-2018/

(ii) Based on the table AND the data display above, approximately what would you expect the **median** number of hours adults aged 75 years and over spend on physical activity to be?

(iii) How do these results compare to a normal distribution with a mean of 7.2 hours and a standard deviation of 2.4 hours?

Briefly compare the centre, spread, and shape of the distribution, using any relevant calculations and sketches to support your answer.

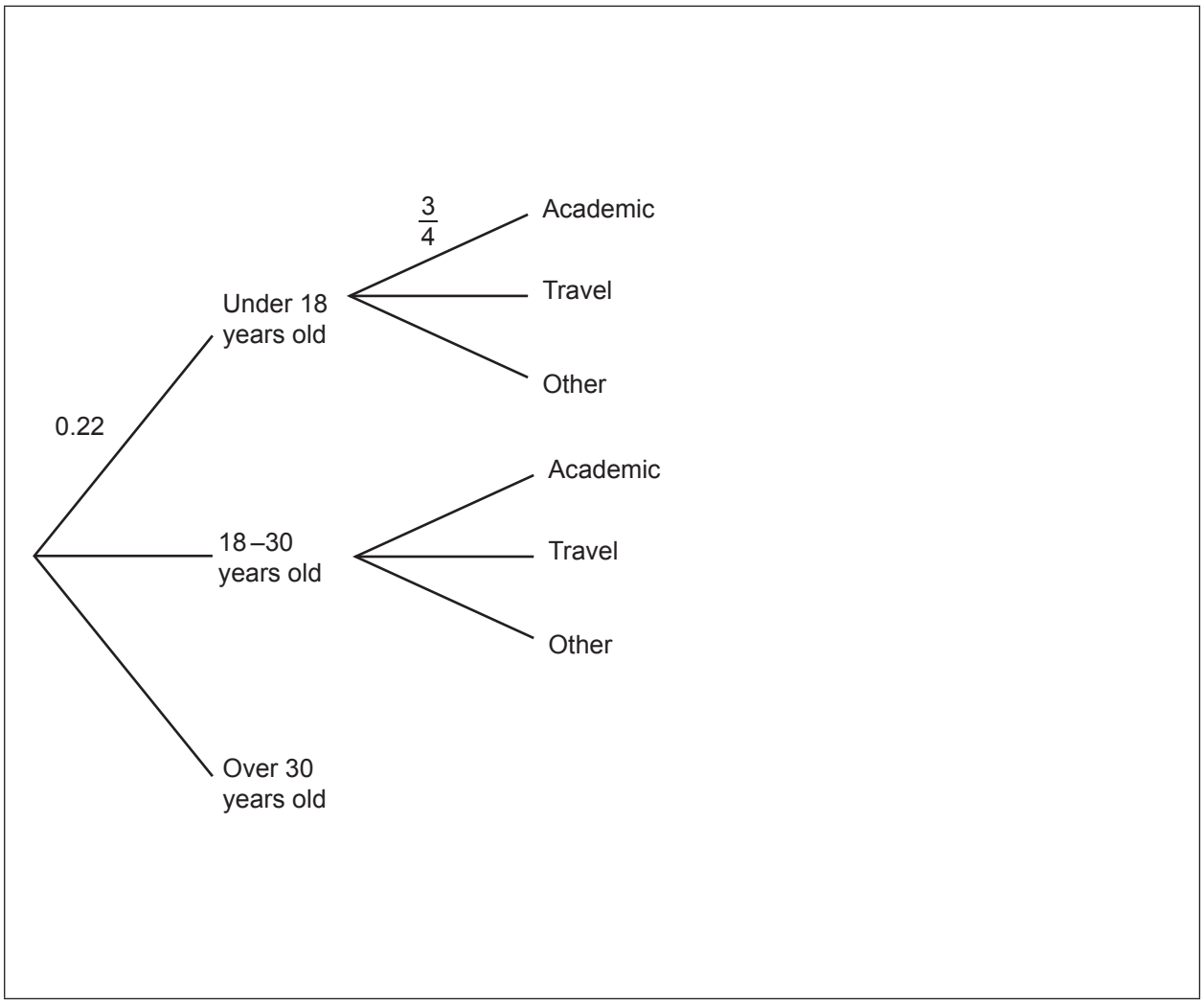
QUESTION TWO

Learning a second language is considered a good way to improve memory, and has also been found to help prevent dementia later in life.

A large study of the users of a popular language learning app found the following:

- Approximately 22% of users of the app were under 18 years of age, 35% were aged 18 to 30, and the rest were over 30.
- Of those who were under 18 years old, ¾ were learning a language using the app for academic reasons (school or work), while 15% were for travel, and the remainder were for other personal reasons, such as family.
- For the 18–30 year old app users, ¼ used it for academic purposes, while 60% used it to prepare for travel, and the rest used it for other personal reasons.

(a) Complete the probability tree and use it to answer the questions below.



(i) What is the probability that an app user chosen at random, is under 18 years old and uses it to learn a language to prepare for travel?

(ii) Out of a randomly selected group of 40 users, how many would you expect to be aged 18–30 years using the app for either academic or travel purposes?

(iii) The survey results also showed:

Of the app users over 30 years old, three times as many people used it for travel than for 'other' reasons.

Overall, 55% of app users of all ages are learning languages for travel.

What is the probability that, given an app user is aged over 30, they are using the app for academic (school or work) purposes?

(iv) It is estimated that about 10% of 18–30 year old users finish the course if their main purpose in learning a language is for academic purposes, while 6% of 18–30 year old users finish the course if their main purpose in learning a language is for travel, and only 2.5% finish the course if they are using the app to learn a language for other reasons.

What is the probability that, if a user aged 18–30 years is chosen at random, they finish the course?

(b) According to the promoters of the language learning app, “learners who buy the premium version are 4.2 times as likely to finish the course as standard users.”

It is known that about 5% of users install the premium version.

It is estimated that the probability of a user chosen at random being a standard user who finishes the course is 3.8%.

If the claim is valid, what is the probability of finishing the course overall?

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The assessment continues on the following page.

QUESTION THREE

Many researchers have found that playing a musical instrument or learning a second language can help to keep people mentally active, and prevent dementia or cognitive impairment later in life.

In one longitudinal study published in 2015, 964 healthy older participants (aged between 60 to 75 years) were asked if they learned a foreign language or studied music before the age of 18. They were then monitored to see if they developed mild cognitive impairment (MCI) over the next 6 years.

These were some of the results:

Table 1: Learned foreign language

		Developed MCI	**No MCI**	**Total**
Learned language (years learned)	**None**	130	134	264
	1–4 years	224	352	576
	over 4 years	42	82	124
	Total	396	568	964

Table 2: Learned musical instrument

		Developed MCI	**No MCI**	**Total**
Learned music (years learned)	**None**	α		346
	1–4 years			360
	over 4 years	85	173	258
	Total	396	568	964

Source: https://psycnet.apa.org/record/2014-32649-001

(a) Use the table(s) above to answer the following questions.

(i) What percentage of participants developed MCI?

(ii) What is the probability that a participant developed MCI, if they learned a language for at least some time (either 1–4 or over 4 years)?

(b) Susie looks at the tables of data and says "it is twice as likely for people to develop MCI if they learn music for over 4 years than if they learn a language for over 4 years."

(i) Explain Susie's incorrect reasoning AND

(ii) with valid calculations, correct her statement.

(c) The relative risk comparing the risk of developing MCI for participants who learned a musical instrument for over 4 years to those who didn't play any music is 0.708.

(i) Use this value to calculate the number of participants who developed MCI but didn't learn any music (labelled α in the Table 2 on page 10).

Question Three continues on the following page.

(ii) A New Zealand article encouraging young people to learn music and languages, quoted the study, claiming that "either learning a musical instrument or a foreign language for over 4 years when young reduces the risk of developing MCI in later life by about 30%, compared to not learning either one."

Evaluate this claim using calculations based on the data above, interpreting the relative risks in context.

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