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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 3 Mathematics and Statistics (Statistics) 2026

91586 Apply probability distributions in solving problems

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Apply probability distributions in solving problems.	Apply probability distributions, using relational thinking, in solving problems.	Apply probability distributions, 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 2–16 in the correct order and that none of these pages is blank.

Do not write in the margins (////). 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.

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QUESTION ONE: STONE SKIMMING

Stone skipping is where a flat stone is thrown across water so it bounces or "skips" multiple times before sinking. The total distance the stone travels before it sinks is called a skim.

New Zealand's first national stone-skimming championship was held in May 2025.

In preparation for this, two friends, Riki and Jaz, have been training regularly. The table below shows the probability distribution of the random variable R, the number of skips per stone throw for Riki.



Source: https://stock.adobe.com/nz/search?k=%22skipping+stones%22&asset_id=88217210

r	4	5	6	7	8
$P(R = r)$	0.15	0.15	0.15	0.35	0.20

(a) Calculate the mean and standard deviation of the number of skips per stone throw for Riki.

Mean: _____

Standard deviation: _____

(b) Riki and Jaz plan on competing in the pairs competition of the stone skimming championship. Each person has one throw, and their final score is their total number of skips from both throws. Let the random variable J be the number of skips per stone thrown by Jaz. The random variable J has $E(J) = 8.4$ and $SD(J) = 2.6$.

(i) Calculate Riki and Jaz's expected final score, and the standard deviation of the score at the end of the pairs competition.

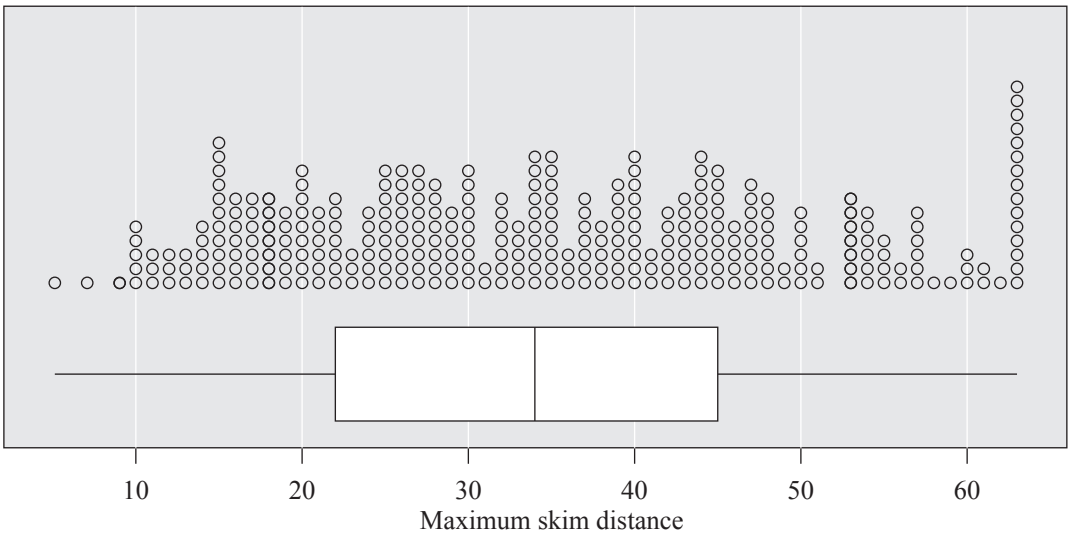
Support your answer with appropriate calculations.

(ii) To calculate your answer to part (b)(i), an assumption is needed to be made.

State this assumption in context.

(c) 320 people from over 25 countries competed in the 2025 World Stone Skimming Championships, held in a water-filled quarry in Scotland. The aim of the competition is to achieve the longest valid skim. A stone that hits the "back wall" of the quarry is automatically recorded as a distance of 63 m. Each competitor is allowed three throws. For a skim to count as valid, the stone must bounce at least twice on the water's surface and land within the designated area.

Figure 1: Maximum skim distance (distance thrown in metres (m)) for each competitor

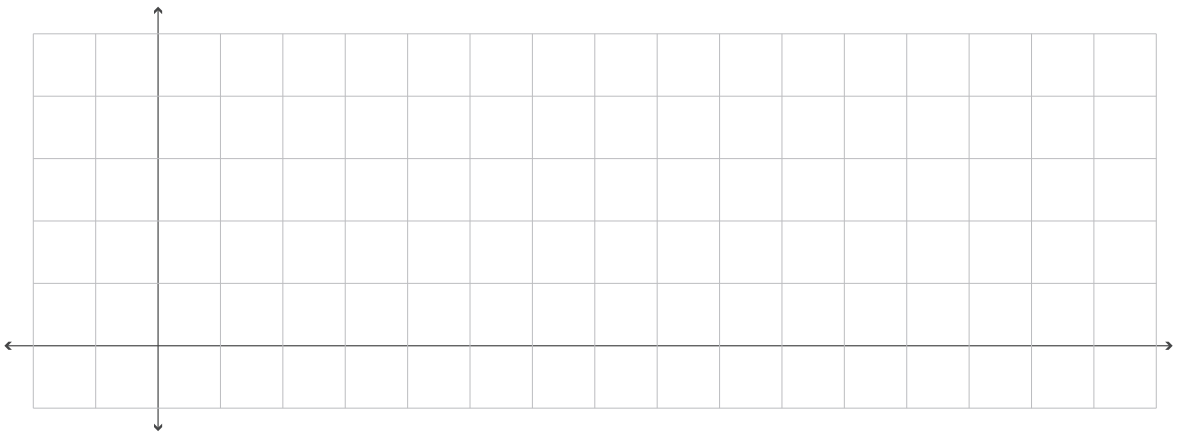


Summary Statistics

Min	LQ	Median	UQ	Max	Mean	SD	Sample Size
5	22	34	45	63	34.59	14.67	320

A normal distribution with a mean of 35 m and standard deviation of 15 m is proposed to model the maximum skim distance of the 2025 World Stone Skimming competitors.

(i) Sketch this normal distribution model on the axes below.



If you need to redraw your response, use the grid on page 11.

(ii) Provide TWO comments discussing the impact of the "back wall" hits on any probabilities calculated using the proposed model.

Support your answer with calculations and statistical reasoning.

1 _____

2 _____

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The assessment continues on the following page.

QUESTION TWO: SPEED PUZZLING

Speed puzzling involves completing a jigsaw puzzle as quickly as possible. In a speed-puzzling event, competitors (known as puzzlers) are each given an identical jigsaw puzzle, sealed in a bag. Puzzlers are given a fixed amount of time to complete the puzzle. For example, a 500-piece puzzle must be finished within two hours. Competitors who complete their puzzles within the time limit are ranked by their finishing time. Those who do not finish in time have their remaining unplaced pieces counted, and are ranked according to that number.



https://cdn.shopify.com/s/files/1/0658/8137/4958/files/Speed_Puzzling_1_480x480.jpg

(a) A local library is holding a speed puzzling event. From previous experience, they estimate that 58% of puzzlers will complete the jigsaw within the time limit.

23 puzzlers register for the event.

(i) Using an appropriate probability distribution model, calculate an estimate for the probability that at least three-quarters of the puzzlers will complete the jigsaw within the time limit.

State the name and parameters of this distribution as part of your answer.

(ii) Justify, in context, the use of the probability distribution for your answer in part (i).

(b) The fastest puzzler at the 2025 New Zealand National Speed Puzzling event completed their 500 piece puzzle in 43 minutes and 35 seconds (2615 seconds), giving an average puzzle completion rate of approximately 11.5 pieces per minute.

(i) Using a Poisson distribution model, calculate an estimate for the probability that this puzzler will place at most 5 pieces in any 30-second period of the competition.

(ii) To apply the Poisson distribution model to this situation, it is assumed that the conditions of the Poisson distribution are satisfied.

Identify TWO conditions in this context, and for each, discuss whether they may hold or not.

1

2

(c) A typical competition puzzler completes a 500-piece puzzle at a rate of 4 pieces per minute.

12 puzzlers take part in a small training event.

Calculate an estimate for the probability that at least six of these puzzlers **don't** complete their 500-piece puzzle within the 2 hour time limit of the competition.

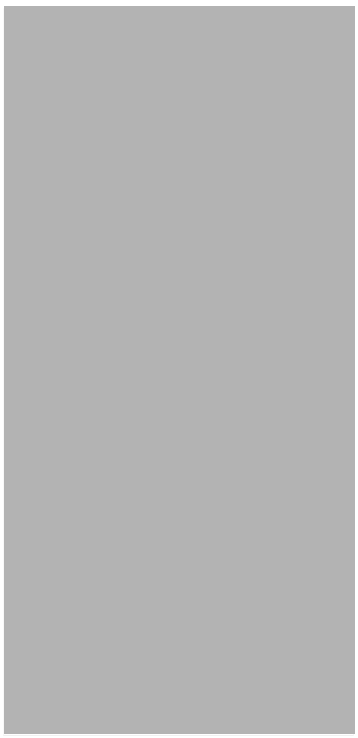
As part of your answer, clearly identify your choice of distribution(s) and associated parameter(s). Show your working clearly.

QUESTION THREE: HOBBY HORSING

Hobby horsing is a sport where competitors use a hobby horse (toy horse) to perform routines similar to those seen in real equestrian competitions.

One event is western riding, where competitors perform a routine and are given points based on the difficulty or well-executed movements. Points are also deducted for mistakes or faults.

Most competitor scores fall between 55 and 85 points, with 70 representing an average performance. Because scores can take any value in this range, including decimals such as tenths, they can be treated as continuous data.



Source: www.summitsaddlery.co.nz/products/br-mini-horse-hobby-horse?variant=50975368020281

(a) Suggest an appropriate probability distribution model that could be used to model the scores of competitors in a western riding event.

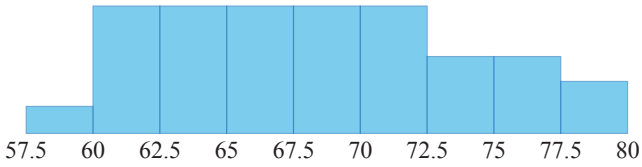
State the parameters of your model.

(b) Use your model suggested in part (a) to calculate an estimate for the probability that a randomly chosen competitor in a western riding event scores less than 65 points.

Show your working clearly.

(c) A small hobby-horsing competition is held in Ashburton, with 34 competitors in the western riding event. The distribution of their scores is shown in Figure 2.

Figure 2: Distribution of scores in Ashburton competition



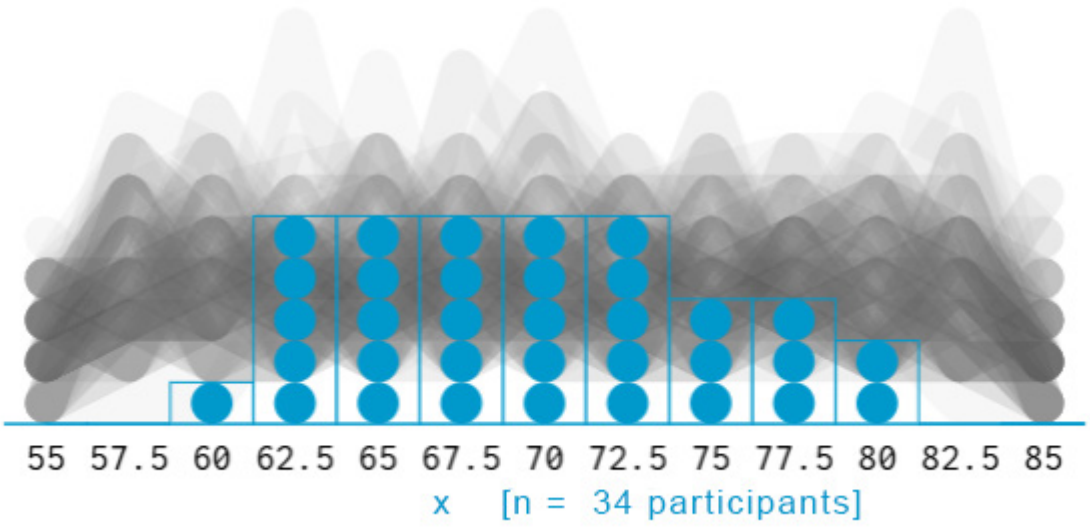
A triangular or a uniform probability distribution model are being considered to model the scores of small hobby-horsing competitions based on the Ashburton competition results.

(i) Use a uniform probability distribution to calculate an estimate for the probability that a randomly chosen competitor in the western riding event at Ashburton scores less than 65 points.

(ii) Justify your choice of model parameters in part (i).

(d) A simulation model of a uniform distribution with a minimum of 55 and a maximum of 85 is run 1000 times and compared to the western riding scores from the Ashburton competition. The results of the simulation model, and the original real observed data are shown in Figure 3.

Figure 3: Simulation model and real observed data for western hobby horsing



(i) Discuss whether this uniform distribution model appears to be appropriate to model the western riding scores from the Ashburton hobby-horsing competition.

As part of your discussion, you should clearly identify the features of the simulation model shown above in Figure 3.

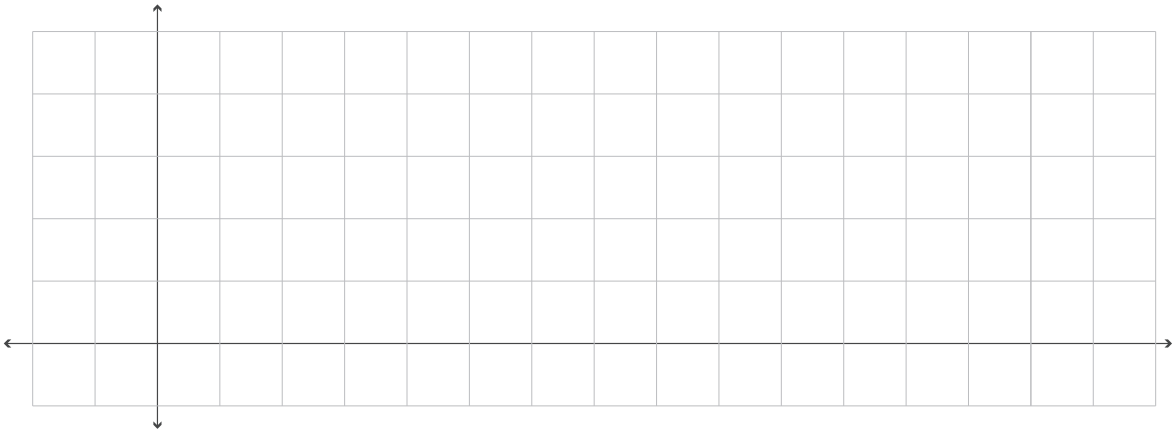
Support your answer with statistical reasoning.

(ii) Discuss whether this uniform distribution model could be appropriate to model western riding scores more generally.

Your discussion may consider the impact of sampling variability.

SPARE DIAGRAMS

If you need to redraw your response to Question One (c)(i), use the grid below. Make sure it is clear which answer you want marked.



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

QUESTION NUMBER

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