

# 3

91586



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SUPERVISOR'S USE ONLY

## Level 3 Mathematics and Statistics (Statistics), 2017

### 91586 Apply probability distributions in solving problems

9.30 a.m. Monday 27 November 2017  
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.**

Show ALL working.

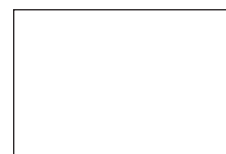
Make sure that you have the Formulae and Tables Booklet L3–STATF.

If you need more room for any answer, use the space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

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

**TOTAL**



ASSESSOR'S USE ONLY

**QUESTION ONE**

- (a) The amount of water used when taking a shower can be modelled by a random variable that takes on values between 20 litres and 200 litres. The most likely amount of water used when taking a shower is 50 litres.
- (i) Using an appropriate probability distribution model, calculate an estimate for the percentage of showers that use less than 50 litres of water.

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- (ii) Using an appropriate probability distribution model, calculate an estimate for the percentage of showers that use more than 40 litres of water.

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- (b) Car drivers can use various mobile phone GPS navigation apps to get an estimate of the time it will take to travel to a destination. A study was carried out to investigate how accurate the travel time estimates were from one particular GPS navigation app. For each trip in the study, the estimated travel time was compared to the actual travel time, and the absolute difference calculated (see the table below).

<b>Trip</b>	<b>Estimated travel time</b>	<b>Actual travel time</b>	<b>Absolute difference between estimated travel time and actual travel time</b>
1	10.4 minutes	11.3 minutes	0.9 minutes
2	6.5 minutes	5.2 minutes	1.3 minutes
3	3.9 minutes	3.9 minutes	0 minutes
...	...	...	...

- (i) Suppose 15% of trips made during the study were classified as “not accurate” using the absolute difference.

If ten trips from the study were chosen at random, using an appropriate model, calculate the probability that at most four of the trips were classified as “not accurate”.

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

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- (iii) The mean absolute difference between the estimated travel time and the actual travel time for trips in this study was 3.5 minutes, with a standard deviation of 2.8 minutes. The study also found that 87% of trips had absolute differences of less than five minutes.

Discuss TWO reasons why it would be inappropriate to use a normal distribution to model the absolute differences between the estimated travel time and the actual travel time for trips.

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**QUESTION TWO**

- (a) The table below shows the probability distribution of the random variable  $X$ .

$x$	0	1	2	3	4
$P(X=x)$	0.11	0.21	0.24	0.25	0.19

- (i)  $E(X) = 2.2$ .

Calculate  $\text{VAR}(X)$ .

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- (ii) The random variable  $Y$  has  $\text{VAR}(Y) = 1.5376$ .

$\text{VAR}(X + Y) = 5.5696$ .

Are  $X$  and  $Y$  independent?

Support your answer with appropriate statistical statements.

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- (b) The average temperature in a New Zealand living room on a winter evening can be modelled by a normal distribution, with mean  $17.8^\circ\text{C}$  and standard deviation  $2.1^\circ\text{C}$ .

- (i) Using this model, between what two values would you expect the middle 95% of average temperatures for New Zealand living rooms on a winter evening to be?

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- (ii) Discuss ONE factor that should be considered when modelling the average temperature in a New Zealand living room on a winter evening.

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- (iii) Suppose that five New Zealand houses were selected at random, and it was found that the average temperature of the living room on a winter evening was below  $16^{\circ}\text{C}$  for four of these houses.

Would finding four or more houses out of five with an average temperature of the living room below  $16^{\circ}\text{C}$  be unlikely under the probability distribution model described above?  
Support your answer with a calculation.

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**QUESTION THREE**

A study collected data on water use within New Zealand homes for the purpose of assisting councils, government agencies, and water suppliers to introduce water efficiency measures.

Prior to the study, it was estimated that each person in New Zealand flushes the toilet on average 4.7 times per 24-hour period.

- (a) (i) Using a Poisson distribution model, calculate an estimate for the probability that a person flushes the toilet less than five times in any 24-hour period.

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- (ii) Give ONE reason why it may not be appropriate to use a Poisson distribution to model the number of toilet flushes for **any 4-hour period**.

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- (b) Data was collected on the number of times each person flushed the toilet during a 24-hour period. The data from 200 people from across 84 homes in the study is summarised in the table below.

<b>Number of toilet flushes during 24-hour period</b>	0	1	2	3	4	5	6	7	8	9	10
<b>Proportion</b>	0	0.01	0.1	0.17	0.26	0.14	0.12	0.11	0.05	0.01	0.03

- (i) Calculate the mean number of toilet flushes made per 24-hour period for people in this study.

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- (ii) Did most people in this study flush the toilet at least four times during a 24-hour period? Support your answer with a calculation.

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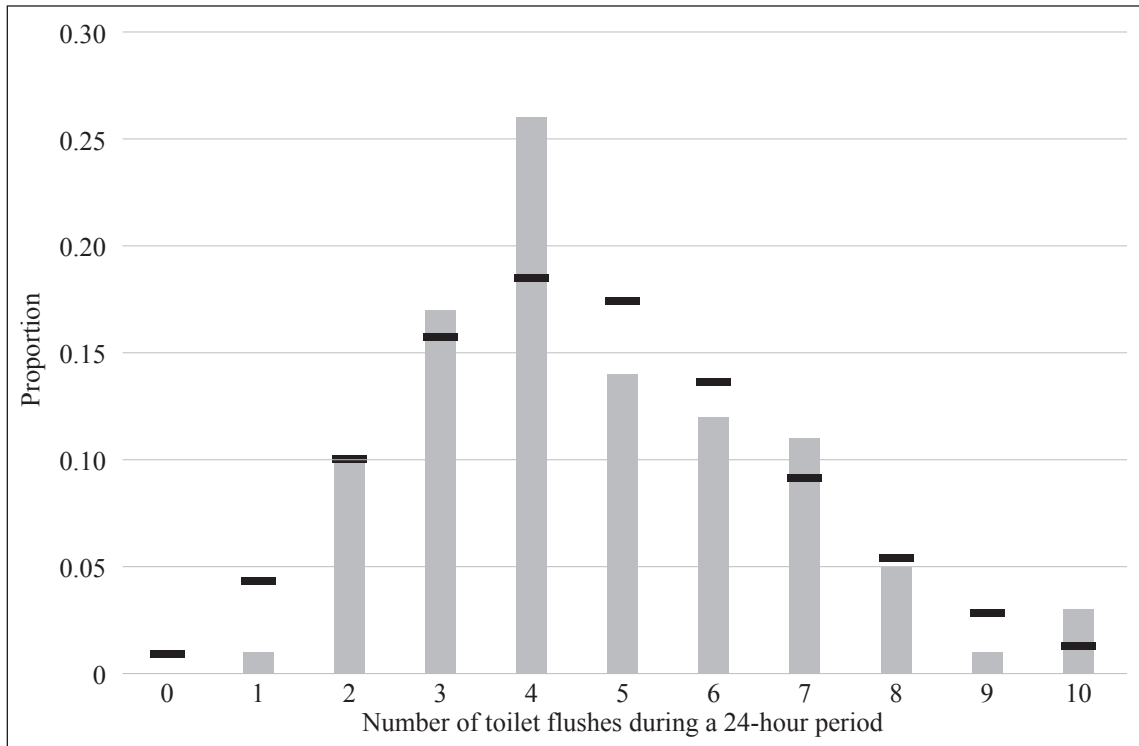


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- (iii) The graph below shows the experimental distribution (shaded bars) and a Poisson distribution with  $\lambda = 4.7$  (the model distribution shown in black).



Discuss TWO reasons why a Poisson distribution with  $\lambda = 4.7$  may not be a good model for the number of toilet flushes for any 24-hour period.

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