Assessment Schedule – 2015

Mathematics and Statistics (Statistics): Apply probability concepts in solving problems (91585)

Evidence Statement

One	Expected Coverage	Achievement (u)	Merit (r)	Excellence (t)
(a)(i)	Risk in 2011 = $\frac{20\,724}{4\,210\,511}$ (or 0.00492). Risk in 2012 = $\frac{17\,807}{4\,248\,612}$ (or 0.00419). Risk in 2013 = $\frac{19\,221}{4\,315\,539}$ (or 0.00445). 2011 is the year with greatest risk.	Correct year determined for greatest overall risk with supportive working.		
(a)(ii)	Possible reasons: • not all stolen vehicles reported • not all stolen vehicles registered.	One issue with the calculation of the overall risk identified OR one type consideration identified but not fully described in context.	One issue with the calculation of the overall risk identified AND one type consideration identified fully described in context.	One issue with the calculation of the overall risk identified AND two types considerations identified fully described in context.
(a)(iii)	Should also consider: • most recent data needed to estimate current risk as there have been differences in each year (the risk is not constant from year to year) • more specific risks associated with factors such as type of car, age of car, location of car, car alarm etc., as these factors will increase or decrease risk.			
(b)(i)	Assuming events "Petrol cap on LHS" and "Car is silver" are independent, P(petrol cap LHS $\cap$ silver) $= 0.228 \times \frac{13}{21} = 0.141$	Combined probability is correctly calculated.	Combined probability is correctly calculated AND assumption stated well.	
(ii)	The estimate of the probability that a car in NZ has its petrol cap on the left-hand side is based on a sample of only 10 cars. This means that the true probability that a car in NZ has its petrol cap on the left-hand side could be much higher or lower than 70% (including below 50%). Without taking sampling variation into account, we can't make a "more likely" claim for a population. *NB: Do not accept discussion around selection bias (or a biased sample). Also, simply stated a bigger sample size is needed is insufficient.*	The likely difference between an estimate of a probability (based on a sample) and the true probability is identified in context OR the need to take into account sampling variability is explained.	The likely difference between an estimate of a probability (based on a sample) and the true probability is identified in context AND the need to take into account sampling variability is explained.	

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Reasonable start / attempt at one part of the question.	Almost complete correct answer	1 of u	2 of u	1 of r	2 of r	1 of t (with minor omission or error)	1 of t

Two	Expected Coverage	Achievement (u)	Merit (r)	Excellence (t)
(a)(i)	Proportion of cars advertised with 0 as last digit $= \frac{6}{20}$ (or equivalent)	Observed proportion AND model estimate correctly calculated.		
(ii)	Model estimate $= \frac{1}{10}$ (or equivalent)			
(iii)	Using the simulation results, you could expect 9 out of 1000 lots of the 20 cars to have 0 as the last digit of the odometer reading. The proportion of cars advertised with 0 as the last digit of the odometer reading is 6/20, which is unlikely to occur by chance acting alone, as it is significantly greater than 9/1000. This suggests another factor is acting with chance. ***Note:*** *It should not be concluded that the importer is rounding the odometer readings as other factors/variables have not been controlled.*	The proportion of cars that could be expected to have 0 as the last digit of the odometer reading of 6 (or more) out of 20 is identified as 9/1000 (or 10/1000).	The proportion of cars that could be expected to have 0 as the last digit of the odometer reading of 6 (or more) out of 20 is identified as 9/1000 (or 10/1000) AND correct conclusion.	
(b)(i)	$P(\text{Japan}) = 0.639$ $P(\text{Used} \mid \text{Japan}) = 0.803$ $P(\text{Japan} \cap \text{Used}) = 0.639 \times 0.803$ $= 0.513$ The events are not mutually exclusive as $P(\text{Japan} \cap \text{Used}) \neq 0$ *Accept other valid reasoning.*	Joint probability is correctly calculated OR logical argument supported with values.	Joint probability is correctly calculated OR logical argument supported with values AND correct explanation as to why the events are not mutually exclusive.	
(ii)	$P(\text{Japan} \cap \text{Used}) = 0.513$ $P(\text{Japan} \cap \text{Used}) > 50\%$, so it is not possible for $P(\text{Not Japan} \cap \text{Used})$ to be a higher probability. In fact, $P(\text{Not Japan} \cap \text{Used})$ can't be greater than 0.361. This means a greater proportion of the used cars must be manufactured in Japan than not. *Accept other valid chains of reasoning e.g. assume worst case scenario P(Used) = 1*		Demonstrated some understanding of the relationship between the conditional probability and the joint probability.	A valid chain of reasoning given for why a used car is more likely to have been manufactured in Japan than not.

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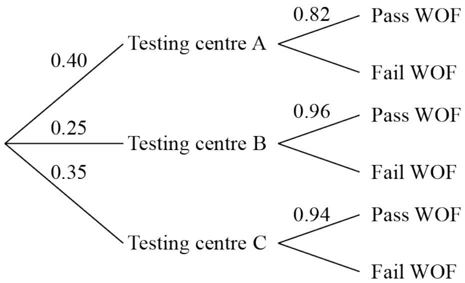
<table>
<tr><th>Three</th><th>Expected Coverage</th><th>Achievement (u)</th><th>Merit (r)</th><th>Excellence (t)</th></tr>
<tr><td>(a)(i)</td><td>Tree completed:



P(successful test)
$= 0.4 \times 0.82 + 0.25 \times 0.96 + 0.35 \times 0.94$
$= 0.897$ (or 89.7 %)</td><td>Probability correctly calculated.</td><td></td><td></td></tr>
<tr><td>(a)(ii)</td><td>Table partially completed (not all values are needed):
<table>
<tr><th></th><th>Testing centre C</th><th>Not testing centre C</th><th>Total</th></tr>
<tr><td>Successful</td><td></td><td></td><td>8 970</td></tr>
<tr><td>Unsuccessful</td><td>210</td><td></td><td>1 030</td></tr>
<tr><td>Total</td><td>3 500</td><td></td><td>10 000</td></tr>
</table>
P(Testing centre C | unsuccessful) = $\frac{210}{1030}$
Accept other valid calculations e.g. finding conditional probability based on provided percentages and formulae.</td><td>A significant step (eg. 210 or 0.021is calculated) is made towards the solution.

OR consistently correct from (a)(i).</td><td>Proportion correctly calculated.</td><td></td></tr>
<tr><td>(a)(iii)</td><td>Possible responses for validity of decision:
Yes – could be valid since this has the highest success rate, but since around 25% of the tests were completed by testing centre B there might be an explanation for this success rate, e.g. the testing centre offers repairs and other car services as well.
No – there is not much of a difference between success rates at testing centre B and testing centre C – so the car owner could decide to go to testing centre C with similar expected results.
No – there could be reasons why testing centre B has higher success rates which may not apply to the car owner, e.g. the cost of the WOF is higher, which means more affluent people (with better cars) use this testing centre.
Accept other valid responses.
The underlying issues are that we do not know why the success rates are different for each testing centre, whether the success rates are ‘stable’ or likely to continue into the future, and whether any differences between test rates for the different centres are significant. An additional note is that the probability that the car of the particular car owner passes its WOF test will be 1 or 0 depending on the condition of the car and/or the judgement of the person carrying out the test.</td><td>The response identifies whether the decision is valid or invalid.

AND

Provides a partial explanation in support.</td><td>The response identifies whether the decision is valid or invalid.

AND

Provides a full explanation in support.</td><td></td></tr>
</table>

(b)	Let M = the age of the motorcycle Let C = the age of the car $P(M \geq 2 \cap C = 0)$ $= 0.238 \times (0.177 + 0.183 + 0.244) = 0.144$ $P(M \geq 3 \cap C = 1)$ $= 0.223 \times (0.183 + 0.244) = 0.095$ $P(M = 4 \cap C = 2)$ $= 0.188 \times 0.244 = 0.0459$ $P(M - C \geq 2) = 0.144 + 0.095 + 0.0459$ $= 0.285$		Probabilities correctly calculated for at least three of the required combinations with communication of strategy used to solve problem.	Probability correctly calculated with clear communication of strategy used to solve problem.

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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 8	9 – 13	14 – 18	19 – 24