Assessment Schedule – 2024

Mathematics and Statistics: Apply probability methods in solving problems (91267)

Evidence

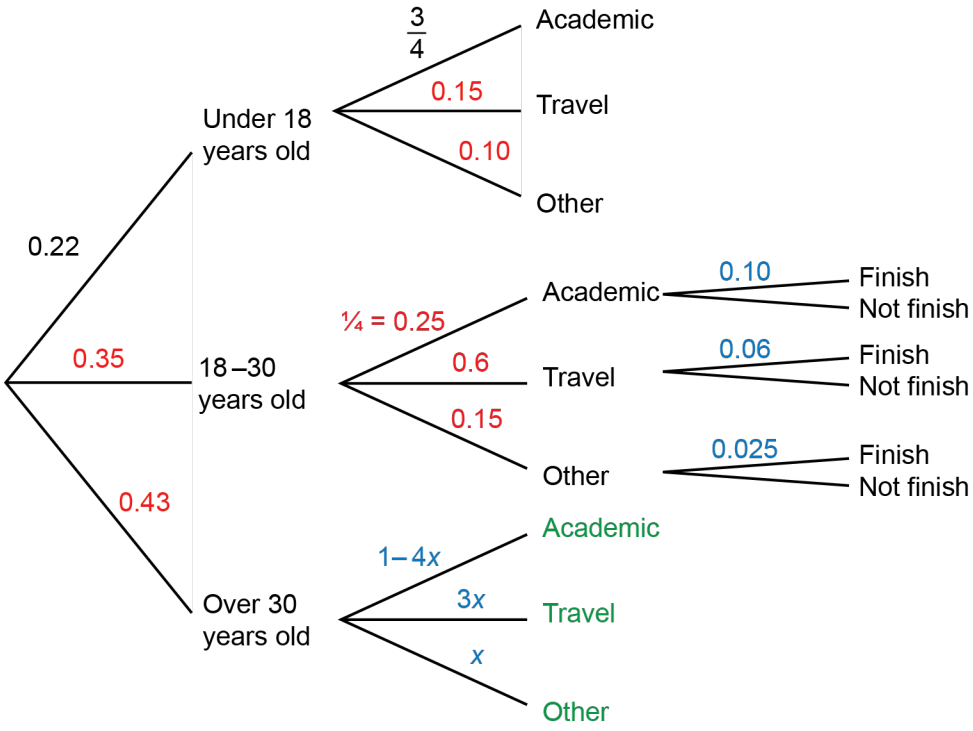
Q	Evidence	Achievement	Merit	Excellence
ONE (a)(i)	Normal distribution $\mu = 10.8$, $\sigma = 3.2$ $P(6 < x < 10.8) = P(-1.5 < z < 0) = 0.4332$	• Probability correct.		
(ii)	$P(X > 16) = 0.05208$ $P(Z > 1.625) = 0.5 - 0.4479 = 0.0521$	• Probability correct.		
(iii)	Inverse normal $P(X < x) = 0.12$ (left tail) $-1.175 = \frac{X - 10.8}{3.2}$ $x = 7.04$, so 7 hours a week (1 hour per day). $z = -1.175$	• CAO. OR $\pm z$-value.	• Correct answer given. Some evidence of working using formula or clearly labelled diagram must be shown.	
(b)(i)	$-1.6449 = \frac{0.5 - 8.1}{\sigma}$ $\sigma = 4.62$	• Correct (negative) z-score.	• Correct standard deviation found with valid working.	**T1:** • Correct standard deviation found with valid working. AND One valid reason why normal distribution may not be appropriate. **T2**: • Correct standard deviation found with valid working. AND TWO different reasons why normal distribution may not be appropriate.
(ii)	**TWO** different comments on non-normal, linking standard deviation in (i) to the reason. Shape (e.g. skew, cluster at 0, so model is truncated or bimodal) Spread (σ too high and would indicate hours going below 0) • The distribution is unlikely to be bell shaped and symmetrical. It is likely to have a cluster of students sitting on 0, which would not be normally distributed (truncated distribution). OR It is more likely to be skewed to the right with some students who spend high hours on physical activity. • Left tail goes below 0 if $\sigma = 4.62$ and $\mu = 8.1$. $P(X < 0) = 0.03978$, which is impossible in this context. • The standard deviation of 4.62 is so large, relative to mean, that it would suggest hours going below 0, which is impossible. Three standard deviations below the mean would be – 5.76 hours so would suggest that 99 % of students spend between – 5.76 and 21.96 hours.	OR CAO.		

(c)(i) (ii) (iii)	Distribution is not normal; it is likely skewed, with cluster at 0, and long upper tail (skewed to right). Median (50%) so would be somewhere in the 150–419 minutes category (using the table) OR About 280 - 400 minutes (using the graph). • Centre: Mean is higher than median (in top 40% so **not** same as median) but in a normal distribution they would be the same. If mean is 7.2 = 432 minutes, this is above the median which must be somewhere between 150–419 minutes. (The mean is higher than the median due to the right skew.) • Spread: standard deviation of 2.4 hours (144 mins) suggests that 99% of 75 year olds spend between 0 and 14.4 hours (860 minutes) – this seems to match the data on the dot plot as only two values are outside that. OR Standard deviation may be different in reality as it does not match the per entages in table if standard deviation is calculated from those. • Shape: Mean being in top 40% suggests the data is not symmetrical and bell-shaped (as normal distribution would be), and therefore has a skew to right.	• Valid suggestion with comment on skewed distribution or cluster at 0 (in part (c)(i)). OR Valid estimate for the median in (ii), within the range of 150 – 419 minutes (or hours).	• Valid estimate for the median in (ii), within the range of 280 – 400 minutes. AND At least ONE valid comparison of a feature of the normal distribution to this distribution.	**T1** Valid estimate for the median in (ii), within the range of 280 – 400 minutes. **AND** At least **TWO** different comparisons of a normal distribution feature (centre, spread or shape) to the given data's distribution.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	A valid attempt at one question.	1 u	2 u	3 u	1r	2r	T1	T2 or 2T1

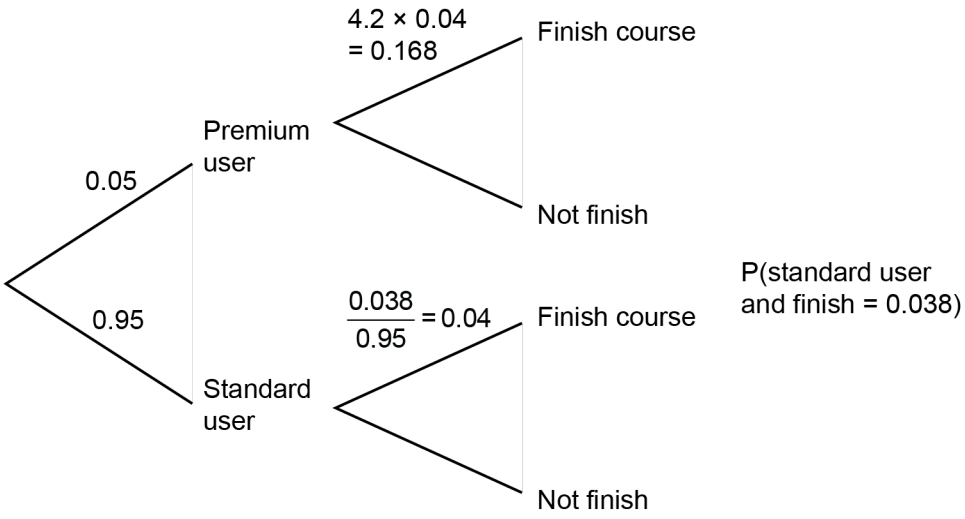
Q	Evidence	Achievement	Merit	Excellence
TWO (a)(i)	P(Youth and using for travel) = 0.22 × 0.15 = 0.033 (Tree information in red below)	• Correct probability.		
(ii)	P(18–30 and using for academic or travel) = 0.35 × 0.25 + 0.35 × 0.6 = 0.0875 + 0.21 = 0.2975 Expect 0.2975 × 40 = 11.9, so 12 (or 11) users.	• Correct probability of either academic or travel.	• Correct expected value (must be a whole number).	
(iii)	P(all ages travel) = 0.22 × 0.15+ 0.35 × 0.6 + 0.43 × 3x = 0.55 0.243 + 1.29x = 0.55 1.29x = 0.307 x = 0.238 = probability of 'other' if adult Therefore 3x = 0.714 (prob of travel if over 30) so probability academic if adult over 30 = 1 – 0.714 – 0.238 = 0.048	• Probability tree set up with 3x and x on correct branches. (This is shown in green in the tree below.)	• Correct algebraic equation set up to find x. OR Alternative communication, maybe in tree.	T1: Correct probability for "other" or "travel". T2: Correct probability of academic users if aged over 30.
(iv)	P(user aged 18–30 finishes course) = ¼ × 0.1 + 0.6 × 0.06 + 0.15 × 0.025 = 0.06475 Will gain grade **u only** if the conditional probability has not been considered : Prob = 0.35 × ¼ × 0.1 + 0.35 × 0.6 × 0.06 + 0.35 × 0.15 × 0.025 = 0.02266	• One correct partial probability or all three extra branches shown on tree. (3rd branch in blue below.)	• Correct probability added.	

Probability tree for Question Two (a)



(b)	P(finish if standard user) $= \frac{0.038}{0.95} = 0.04$ P(finish if premium user) = 0.04 × 4.2 = 0.168 P(finish course) = 0.95 × 0.04 + 0.05 × 0.168 = 0.0464	• Probability of finishing for standard user found.	• Probability of finishing course found with clear working (correct method) shown.	

Probability tree for Question Two (b)



NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	A valid attempt at one question.	1 u	2 u	3 u	1r	2r	T1	T2

<table>
<tr><th>Q</th><th>Evidence</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>THREE
(a)(i)</td><td>P(MCI) = $\frac{396}{964} = 0.411 = 41.1\%$</td><td>• Correct percentage.</td><td></td><td></td></tr>
<tr><td>(ii)</td><td>P(participant develops MCI given learning language 1–4 or over 4 years)
$= \frac{224+42}{576+124} = \frac{266}{700} = 0.38$</td><td>• Calculation of both probabilities:
$\frac{224}{576}$ and $\frac{42}{124}$.</td><td>• Correct probablitiy.</td><td></td></tr>
<tr><td>(b)(i) and (ii)</td><td>Susie only looked at the raw numbers, seeing that 85 is over double 42.
However, looking at the probabilities as well as the proportions:
p(develop MCI if learned music over 4 years
$= \frac{85}{258} = 0.3295.$
p(develop MCI if learned a language over 4 years
$= \frac{42}{124} = 0.3387.$
These probabilities are very close to each other, so Susie's conclusion should be that "the chance of developing MCI is very similar for those who learn a language or music for over 4 years".
Justification could include the Relative Risk of 1.028 or 0.9727 which is close to 1, so very similar.
Accept Susie's alternative conclusion that it is slightly (3%) more likely to develop MCI if learning a language for over 4 years compared to music.</td><td>• At least one correct probability of developing MCI for
EITHER
music
OR
• language learners calculated.</td><td>• Both probabilities given .
AND
with correct version of Susie's conclusion.
OR
Susie's incorrect reasoning explained, based on raw numbers.</td><td>T1 :
Both probabilities given
AND
with correct version of Susie's conclusion.
AND
Susie's incorrect reasoning explained,
based on raw numbers.</td></tr>
<tr><td>(c)(i)</td><td>Relative risk calculation:
$\frac{85/258}{a/346} = 0.708$ (1)
$\frac{a}{346} = \frac{0.3295}{0.708} = 0.4653$ (2)
(prob of developing MCI if no music learned)
$a = 0.4653 \times 346 = 161.006$
= 161 participants.

Table 2: Question Three (a)(iv) Learned musical instrument
<table>
<tr><th colspan="2"></th><th>Developed MCI</th><th>No MCI</th><th>Total</th></tr>
<tr><td rowspan="4">Learned music (years learned)</td><td>None</td><td>a
161</td><td>185</td><td>346</td></tr>
<tr><td>1–4 years</td><td>150</td><td>210</td><td>360</td></tr>
<tr><td>over 4 years</td><td>85</td><td>173</td><td>258</td></tr>
<tr><td>Total</td><td>396</td><td>568</td><td>964</td></tr>
</table></td><td>• Evidence of equation (1) (or equivalent).
OR
Probability of 0.4653 (2).</td><td>• Correct number of participants found, must be whole number.</td><td></td></tr>
</table>

(ii)	Relative Risk of developing MCI if learn language for 4 years compared to none = $\frac{42/124}{130/264} = \frac{0.3387}{0.4924} = 0.6878$ 0.68 times as likely which is 31% less likely (1–0.6878 = 0.3122) for people who learn a language for at least 4 years to develop MCI compared to those who don't learn a language. RR of developing MCI if learn music for over 4 years compared to none = 0.708 (given in part (i). I.e. it is 29.2% less likely for people who learn music for at least 4 years to develop MCI compared to those who do not learn music. Both claims are about 30% less likely (29% and 31%) so this claim could be valid as it says about 30%. (Accept neither exactly 30% so claim is not valid if RRs are clearly calculated and interpreted).	• Calculation of the inverted Relative Risk for learning language: $\frac{130/264}{42/124} = \frac{0.4924}{0.3387} = 1.4538$	• Relative Risk for learning language is calculated but not interpreted or correct. OR Candidate uses multiplicative reasoning to evaluate a claim.	**T1:** Correct RR for learning language calculated AND interpreted in context (31% less likely). **T2**: Both RRs interpreted as a percentage less likely *in context* (for music and languages) AND Claims evaluated.

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No response; no relevant evidence.	A valid attempt at one question.	1u	2u	3u	1r	2r	T1	T2 or 2T1

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 07	08 – 12	13 – 18	19 – 24