2009 ASL Mathematics & Statistics 數學及統計學

評卷參考 Marking Scheme (此部分只設英文版本)

AS Mathematics and Statistics

General Instructions To Markers

1. It is very important that all markers should adhere as closely as possible to the marking scheme. In many cases, however, candidates will have obtained a correct answer by an alternative method not specified in the marking scheme. In general, a correct alternative solution merits all the marks allocated to that part, unless a particular method has been specified in the question. Markers should be patient in marking alternative solutions not specified in the marking scheme.

2. For the convenience of markers, the marking scheme was written as detailed as possible. However, it is likely that candidates would not present their solution in the same explicit manner, e.g. some steps would either be omitted or stated implicitly. In such cases, markers should exercise their discretion in marking candidates' work. In general, marks for a certain step should be awarded if candidates' solution indicated that the relevant concept / technique had been used.

3. In marking candidates' work, the benefit of doubt should be given in the candidates' favour.

4. Unless the form of the answer is specified in the question, alternative simplified forms of answers different from those in the marking scheme should be accepted if they are correct.

5. Unless otherwise specified in the question, use of notations different from those in the marking scheme should not be penalised.

6. In the marking scheme, marks are classified into the following three categories:

'M' marks	–	awarded for applying correct methods
'A' marks	–	awarded for the accuracy of the answers
Marks without 'M' or 'A'	–	awarded for correctly completing a proof or arriving at an answer given in the question.

   In a question consisting of several parts each depending on the previous parts, 'M' marks should be awarded to steps or methods correctly deduced from previous answers, even if these answers are erroneous. (I.e. Markers should follow through candidates' work in awarding 'M' marks.) However, 'A' marks for the corresponding answers should NOT be awarded, unless otherwise specified.

7. In the marking scheme, steps which can be skipped are enclosed by dotted rectangles, whereas alternative answers are enclosed by $\boxed{\text{solid rectangles}}$.

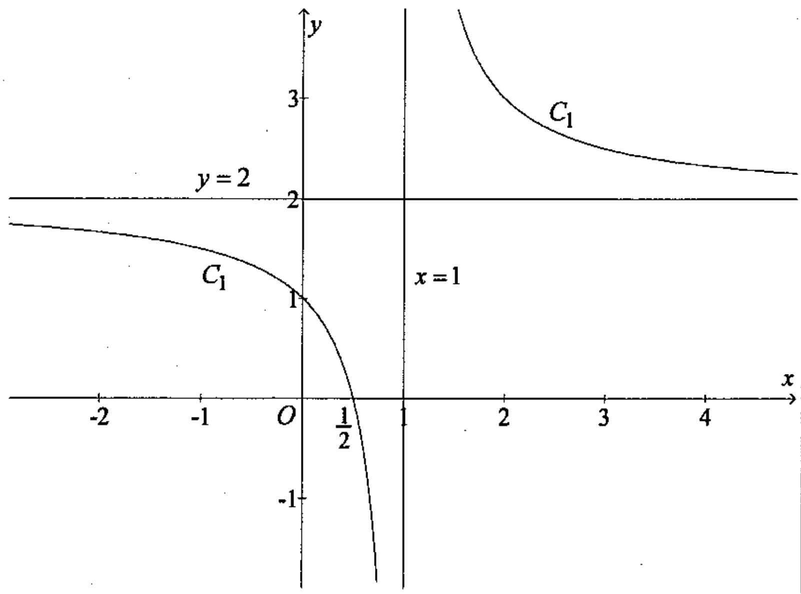
8. Marks may be deducted for poor presentation (*pp*). The symbol (*pp*–1) should be used to denote 1 mark deducted for *pp*.
   (a) At most deduct 1 mark for *pp* in each section.
   (b) In any case, do not deduct any marks for *pp* in those steps where candidates could not score any marks.

9. Marks may be deducted for numerical answers with inappropriate degree of accuracy (*a*). The symbol (*a*–1) should be used to denote 1 mark deducted for *a*.
   (a) At most deduct 1 mark for *a* in each section.
   (b) In any case, do not deduct any marks for *a* in those steps where candidates could not score any marks.

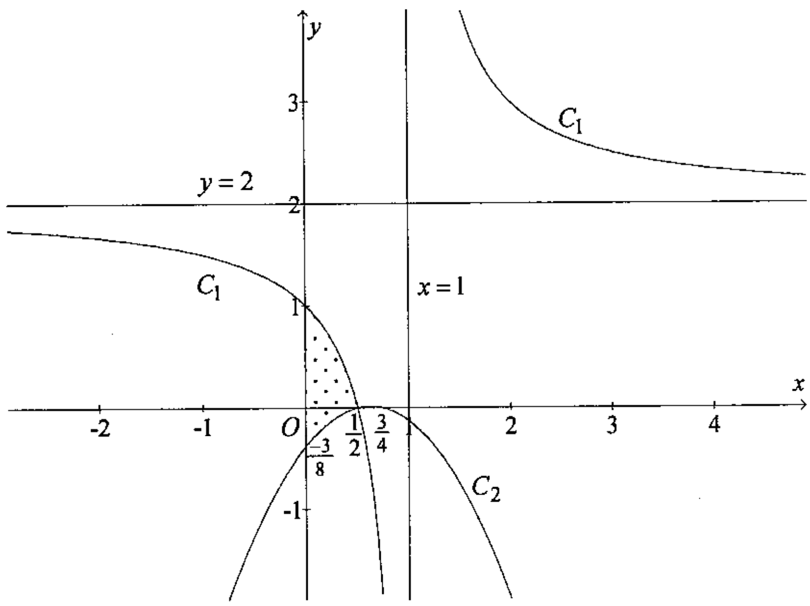
10. Marks entered in the Page Total Box should be the NET total scored on that page.

Solution	Marks	Remarks
1. (a) $\dfrac{1}{\sqrt{1-x}}=(1-x)^{\frac{-1}{2}}$		
$=1-\left(\dfrac{-1}{2}\right)x+\dfrac{1}{2!}\left(\dfrac{-1}{2}\right)\left(\dfrac{-1}{2}-1\right)x^2-\dfrac{1}{3!}\left(\dfrac{-1}{2}\right)\left(\dfrac{-1}{2}-1\right)\left(\dfrac{-1}{2}-2\right)x^3+\cdots$	1M	For any two terms correct
$=1+\dfrac{1}{2}x+\dfrac{3}{8}x^2+\dfrac{5}{16}x^3+\cdots$	1A	(pp-1) if $\cdots$ was omitted
(b) $\therefore\ \dfrac{1}{\sqrt{1-\frac{1}{5}}}=1+\dfrac{1}{2}\left(\dfrac{1}{5}\right)+\dfrac{3}{8}\left(\dfrac{1}{5}\right)^2+\dfrac{5}{16}\left(\dfrac{1}{5}\right)^3+\cdots$		
$\dfrac{\sqrt{5}}{2}\approx\dfrac{447}{400}$	1A	For L.H.S.
$\sqrt{5}\approx\dfrac{447}{200}$	1A	OR $2\dfrac{47}{200}$ OR 2.235
(c) The expansion in (a) is valid only when $\lvert x\rvert<1$.	1A	
So Josephine cannot put $x=-4$ into the expansion and her claim is incorrect.	1	
	(6)	
2. (a) $\dfrac{dP}{dt}=\dfrac{-0.09}{\sqrt{3t+1}}$		
$P=\displaystyle\int\dfrac{-0.09}{\sqrt{3t+1}}dt$		
$=-0.06\sqrt{3t+1}+C$	1M+1A	Withhold 1A if C was omitted
When $t=0$, $P=1$.		
$\therefore\ 1=-0.06\sqrt{1}+C$		
$C=1.06$		
i.e. $P=-0.06\sqrt{3t+1}+1.06$	1A	
(b) When $t=5$, $P=-0.06\sqrt{3(5)+1}+1.06=0.82$	1M	
Thus, 18% of the population has died off.	1A	
(c) When $P=0$, $0=-0.06\sqrt{3T+1}+1.06$		
$T=103\dfrac{19}{27}$	1A	OR 103.7037
	(6)	
3. (a) $x=y^4-y$		
$\dfrac{dx}{dy}=4y^3-1$	1M	For finding $\dfrac{dx}{dy}$
$\therefore\ \dfrac{dy}{dx}=\dfrac{1}{4y^3-1}$	1M+1A	1M for $\dfrac{dy}{dx}=\dfrac{1}{\frac{dx}{dy}}$
<u>Alternative Solution</u>		
$1=4y^3\dfrac{dy}{dx}-\dfrac{dy}{dx}$	1M+1M	1M for finding $\dfrac{dy}{dx}$; 1M for chain rule
$\therefore\ \dfrac{dy}{dx}=\dfrac{1}{4y^3-1}$	1A	

Solution	Marks	Remarks
(b) $\therefore \quad \dfrac{1}{4y^3-1}=\dfrac{1}{3}$	1M	
$y=1$		
$\therefore \quad x=1^4-1=0$	1A	
Hence the required equation of the tangent is		
$y-1=\dfrac{1}{3}(x-0)$	1M	
i.e. $x-3y+3=0$	1A	
	(7)	
4. (a) $\mathrm{P}(A\cup B)=\mathrm{P}(A)+\mathrm{P}(B)-\mathrm{P}(A\cap B)$		
$\therefore \quad \dfrac{5}{12}=a+\dfrac{1}{4}-\mathrm{P}(A\cap B)$	1A	
i.e. $\mathrm{P}(A\cap B)=a-\dfrac{1}{6}$	1A	
(b) $\mathrm{P}(B')\mathrm{P}(A\mid B')=\mathrm{P}(A\cap B')$		
$[1-\mathrm{P}(B)]\cdot\mathrm{P}(A\mid B')=\mathrm{P}(A)-\mathrm{P}(A\cap B)$		OR $\cdots=\mathrm{P}(A\cup B)-\mathrm{P}(B)$
$\therefore \quad \left(1-\dfrac{1}{4}\right)k=a-\left(a-\dfrac{1}{6}\right)$	1M+1M+1M	OR $\cdots=\dfrac{5}{12}-\dfrac{1}{4}$
i.e. $k=\dfrac{2}{9}$	1A	
(c) Since A and B are independent, $\mathrm{P}(A\cap B)=\mathrm{P}(A)\times\mathrm{P}(B)$.		
$\therefore \quad a-\dfrac{1}{6}=a\times\dfrac{1}{4}$	1M	
$a=\dfrac{2}{9}$	1A	
<u>Alternative Solution</u>		
Since A and B are independent, $\mathrm{P}(A\mid B')=\mathrm{P}(A)$.		
$\therefore \quad a=k$	1M	
$=\dfrac{2}{9}$	1A	
	(8)	
5. (a) The required probability		
$=1-(0.64)^{15}-C_1^{15}(0.36)(0.64)^{14}-C_2^{15}(0.36)^2(0.64)^{13}-C_3^{15}(0.36)^3(0.64)^{12}$	1M+1A	
≈ 0.8469	1A	
(b) The required probability		
$=\dfrac{3\times C_1^5(0.36)(0.64)^4\times C_1^5(0.36)(0.64)^4\times C_2^5(0.36)^2(0.64)^3}{C_4^{15}(0.36)^4(0.64)^{11}}$	1M+1A	OR $=\dfrac{C_1^3\cdot\dfrac{4!}{2!\,1!\,1!}\cdot\dfrac{11!}{3!\,4!\,4!}}{\dfrac{15!}{5!\,5!\,5!}}$
$=\dfrac{50}{91}$	1A	OR 0.5495
	(6)	

Solution	Marks	Remarks
6. (a) Let a_i, b_i be the salaries in groups A and B respectively and $\bar{x}$ be the common mean.		
Let σ_A, σ_B, σ_{total} be the s.d. of the two groups and the pooled group respectively.		
$\sigma_A{}^2 = \dfrac{\sum_{i=1}^{11}(a_i-\bar{x})^2}{11}$ and $\sigma_B{}^2 = \dfrac{\sum_{i=1}^{7}(b_i-\bar{x})^2}{7}$	1M	OR $\sigma_A{}^2 = \dfrac{\sum_{i=1}^{11} a_i{}^2}{11} - \bar{x}^2$, ...
$\sigma_{\text{total}}{}^2 = \dfrac{\sum_{i=1}^{11}(a_i-\bar{x})^2 + \sum_{i=1}^{7}(b_i-\bar{x})^2}{11+7}$	1A	OR $\sigma_{\text{total}}{}^2 = \dfrac{\sum_{i=1}^{11} a_i{}^2 + \sum_{i=1}^{7} b_i{}^2}{11+7} - \bar{x}^2$
$\therefore \quad \sigma_{\text{total}} = \sqrt{\dfrac{11(2.5)^2 + 7(2.8)^2}{18}}$		
≈ 2.6208 thousand dollars	1A	OR $2620.7505
(b) (i) The salary of the manager with the second highest salary in group A is at least $40000 and that in group B is exactly $40000.	1A	For either salary
Hence, the salary of the manager with the second highest salary in group A is not lower than that in group B.	1A	Follow through
(ii) The upper quartile will be changed from the 6th observation to the 5th one and so it will be less than or equal to the original one. The lower quartile will be unchanged (the 2nd observation).	1A	Before: ○ ● ○ ○ ○ ● ○ After: ○ ● ○ ○ ● ○
Hence, the inter-quartile range will be unchanged or decreased.	1A	Follow through
	(7)	
7. (a) (i) The vertical asymptote of $C_1 : y = \dfrac{2x-1}{hx-1}$ is $x = \dfrac{1}{h}$.		
Hence, $\dfrac{1}{h} = 1$		
i.e. $h = 1$	1A	
The horizontal asymptote of $C_1 : y = \dfrac{2x-1}{hx-1}$ is $y = \dfrac{2}{h}$.		
Hence, $\dfrac{2}{(1)} = k$		
i.e. $k = 2$	1A	
(ii) 	1A 1A 1A	For asymptotes For intercepts For shape
		(pp-1) for all labels of axes and origin omitted
	(5)	

Solution	Marks	Remarks
(b) (i) Since $C_2: y=-x^2+px+q$ passes through $\left(\frac{1}{2},0\right)$,		
$\frac{-1}{4}+\frac{p}{2}+q=0$ ——— (*)	1M	
$\frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{2x-1}{x-1}\right)=\frac{(x-1)(2)-(2x-1)(1)}{(x-1)^2}$	1M	
$=\frac{-1}{(x-1)^2}$	1A	
$\frac{\mathrm{d}}{\mathrm{d}x}(-x^2+px+q)=-2x+p$		
Since the tangents of C_1 and C_2 at $\left(\frac{1}{2},0\right)$ are perpendicular to each other,		
$\frac{-1}{\left(\frac{1}{2}-1\right)^2}\cdot\left[-2\left(\frac{1}{2}\right)+p\right]=-1$	1M	
$p=\frac{5}{4}$ By (*), $q=\frac{-3}{8}$	1A	For both
(ii)		



Solution	Marks	Remarks
(ii)	1A	For the shape of C_2
(iii) The required area $=\int_0^{\frac{1}{2}}\left[\frac{2x-1}{x-1}-\left(-x^2+\frac{5}{4}x-\frac{3}{8}\right)\right]\mathrm{d}x$	1M	
$=\int_0^{\frac{1}{2}}\left(2+\frac{1}{x-1}+x^2-\frac{5}{4}x+\frac{3}{8}\right)\mathrm{d}x$	1M	For $2+\frac{1}{x-1}$
$=\left[\ln\lvert x-1\rvert+\frac{x^3}{3}-\frac{5x^2}{8}+\frac{19}{8}x\right]_0^{\frac{1}{2}}$	1A	For $\frac{x^3}{3}-\frac{5x^2}{8}+\frac{19}{8}x$
$=\frac{103}{96}-\ln 2$	1A	OR 0.3798
	(10)	

Solution	Marks	Remarks
8. (a) (i) $R = kt^{1.2}e^{\frac{\lambda t}{20}}$		
$\ln R = \ln k + 1.2\ln t + \frac{\lambda t}{20}$		
$\ln R - 1.2\ln t = \frac{\lambda}{20}t + \ln k$ which is a linear function of t	1A	
(ii) intercept on the vertical axis $= \ln k = 2.89$		
$k \approx 18$ (correct to the nearest integer)	1A	
slope $= \frac{\lambda}{20} = -0.05$		
$\lambda = -1$	1A	
(iii) $\therefore \quad R = 18t^{1.2}e^{-0.05t}$		
$\frac{\mathrm{d}R}{\mathrm{d}t} = 18[1.2t^{0.2}e^{-0.05t} + t^{1.2}e^{-0.05t}(-0.05)]$	1M	
$= 0.9t^{0.2}e^{-0.05t}(24-t)$		
$\begin{array}{cccc} \hline & 0<t<24 & t=24 & 24<t\le 30 \\ \hline \frac{\mathrm{d}R}{\mathrm{d}t} & >0 & 0 & <0 \\ \hline \end{array}$	1M	
Hence, R will attain maximum after 24 months.	1A	
$R = 18(24)^{1.2}e^{-0.05(24)}$		
≈ 245.6815916		
Hence, the maximum population size is 246 hundreds.	1A	
	(7)	
(b) (i) When $t = 0$, $L - 20(6e^0 + 0^3) = Q = 240$		
$\therefore \quad L = 360$	1A	
(ii) $e^{-t} = 1 + (-t) + \frac{(-t)^2}{2!} + \frac{(-t)^3}{3!} + \cdots$		
$= 1 - t + \frac{t^2}{2} - \frac{t^3}{6} + \cdots$	1A	
$\therefore \quad Q = 360 - 20\left[6\left(1 - t + \frac{t^2}{2} - \frac{t^3}{6} + \cdots\right) + t^3\right]$		
$= 360 - 20(6 - 6t + 3t^2 + \cdots)$		
$\approx 240 + 120t - 60t^2$ which is a quadratic polynomial	1A	
(iii) Let $300 = Q = 240 + 120t - 60t^2$ (by (b)(ii))	1M	
i.e. $t^2 - 2t + 1 = 0$		
Hence, when $t = 1$, the species of fish will reach a population size of 300.	1A	Follow through
(iv) $Q = L - 20(6e^{-t} + t^3)$		
$= 360 - 20\left[6\left(1 - t + \frac{t^2}{2!} - \frac{t^3}{3!} + \frac{t^4}{4!} - \frac{t^5}{5!} + \frac{t^6}{6!} - \frac{t^7}{7!} + \cdots\right) + t^3\right]$		
$= 240 + 120t - 60t^2 - 120\left[\left(\frac{t^4}{4!} - \frac{t^5}{5!}\right) + \left(\frac{t^6}{6!} - \frac{t^7}{7!}\right) + \cdots\right]$		

Solution	Marks	Remarks
$= 300 - 60(t-1)^2 - 120\left[\frac{t^4}{5!}(5-t)+\frac{t^6}{7!}(7-t)+\cdots\right]$	1M+1M	1M for completing square 1M for factorization
Since $0 \le t \le 2$, $Q < 300$ and so the conclusion in (b)(iii) is no more valid.	1A	Follow through
	(8)	
9. (a) (i) $R_6 = \int_0^6 \ln(2t+1)\,dt$		
$\approx \frac{1}{2}\{\ln(2\cdot 0+1)+2[\ln(2\cdot 1+1)+\ln(2\cdot 2+1)+\ln(2\cdot 3+1)+\ln(2\cdot 4+1)$ $+\ln(2\cdot 5+1)]+\ln(2\cdot 6+1)\}$	1M	
$= 10.53155488$ The total amount of revenue in the first 6 weeks is 10.5316 million dollars.	1A	
(ii) Let $f(t) = \ln(2t+1)$ $f'(t) = \frac{2}{2t+1}$ $f''(t) = \frac{-4}{(2t+1)^2}$	1A	
< 0 for $0 \le t \le 6$ $\therefore$ $f(t)$ is concave downward for $0 \le t \le 6$. Hence the estimate in (a)(i) is an under-estimate.	1A	Follow through
	(4)	
(b) (i) $Q_1 = \int_0^1 \left[45t(1-t)+\frac{1.58}{t+1}\right]dt$	1A	
$= \left[45\left(\frac{t^2}{2}-\frac{t^3}{3}\right)+1.58\ln\|t+1\|\right]_0^1$ $= \frac{15}{2}+1.58\ln 2$ ≈ 8.595172545 The total amount of revenue in the first week is 8.5952 million dollars.	1A	
(ii) $Q_n = Q_1 + \int_1^n \frac{30e^{-t}}{(3+2e^{-t})^2}dt$	1M	
Let $u = 3+2e^{-t}$ $du = -2e^{-t}dt$ $\therefore$ $Q_n = Q_1 + \int_{3+2e^{-1}}^{3+2e^{-n}} \frac{-15}{u^2}du$	1M	For $\frac{-15}{u^2}$
$= Q_1 + \left[\frac{15}{u}\right]_{3+2e^{-1}}^{3+2e^{-n}}$	1A	For $\left[\frac{15}{u}\right]_{3+2e^{-1}}^{3+2e^{-n}}$
$= \frac{15}{2}+1.58\ln 2+\frac{15}{3+2e^{-n}}-\frac{15}{3+2e^{-1}}$ Hence the total amount of revenue in the first n weeks is $\left(\frac{15}{2}+1.58\ln 2+\frac{15}{3+2e^{-n}}-\frac{15}{3+2e^{-1}}\right)$ million dollars, where $n > 1$.	1A	Accept $4.5799+\frac{15}{3+2e^{-n}}$
	(6)	

Solution	Marks	Remarks
(c) For $n>6$, $R_n = R_6 + \int_6^n 0\,dt \approx 10.5316$ (by (a)(i))	1M	For $\int_6^n 0\,dt = 0$
When $n \to \infty$, $e^{-n} \to 0$ and so $Q_n \to 4.5799 + \frac{15}{3+0} = 9.5799$	1M	For $e^{-n} \to 0$
Therefore, over a long period of time, plan A produces approximately 10.5316 million dollars and plan B produces 9.5799 million dollars of revenue.	1A	
Moreover, the revenue of plan A is even an under-estimate.	1M	
Hence, plan A will produce more revenue over a long period of time.	1A	Follow through
	(5)	
10. (a) (i) The required probability $= \frac{1}{C_3^9} = \frac{1}{84}$	1A	OR 0.0119
(ii) The required probability $= \frac{C_3^4}{C_3^9} = \frac{1}{21}$	1A	OR 0.0476
	(2)	
(b) $(1-p)\left(\frac{1}{84}\right) + p\left(\frac{1}{21}\right) \le \frac{1}{60}$	1M+1A	(pp-1) for using "="
$5 - 5p + 20p \le 7$		
$p \le \frac{2}{15}$		
Hence, the largest value of p should be $\frac{2}{15}$.	1A	OR 0.1333
	(3)	
(c) (i) The required probability $= \frac{2}{15} \cdot \frac{1}{C_4^9}$	1M	For using (b)
$= \frac{1}{945}$	1A	OR 0.0011
(ii) The required probability $= \left(1 - \frac{2}{15}\right) \cdot \frac{C_3^3 C_1^6}{C_4^9} + \frac{2}{15} \cdot \frac{C_3^4 C_1^5}{C_4^9}$	1M+1A	
$= \frac{59}{945}$	1A	OR 0.0624
(iii) The probability of exactly 2 logos are found on 1 card $= \left(1 - \frac{2}{15}\right) \cdot \frac{C_2^3 C_2^6}{C_4^9} + \frac{2}{15} \cdot \frac{C_2^4 C_2^5}{C_4^9}$	1M	
$= \frac{47}{126}$	1A	OR 0.3730
Hence, the required probability $= \left(\frac{1}{945} + \frac{59}{945}\right)^2 + 2\left(\frac{1}{945} + \frac{59}{945}\right)\left(1 - \frac{1}{945} - \frac{59}{945}\right) + \left(\frac{47}{126}\right)^2$	1M+1A	
$= \frac{1387}{5292}$	1A	OR 0.2621
	(10)	

Solution	Marks	Remarks
11. Let X_N cm and X_D cm be the widths of the tongue of a normal baby and a baby having inherited disease A respectively.		
(a) $P(X_N < 2.22) = 0.242$		
$\frac{2.22-\mu}{0.4} = -0.7$		
$\mu = 2.5$	1A	
	(1)	
(b) (i) The required probability		
$= P(X_N > 2.5+0.5)$		
$= P\left(Z > \frac{3-2.5}{0.4}\right)$	1M	
$= 0.5 - 0.3944$		
$= 0.1056$	1A	
(ii) The required probability		
$= 0.05 \times P(X_D < 2.5+0.5) + 0.95 \times P(X_N > 2.5+0.5)$	1M+1A	
$= 0.05 \times P\left(Z < \frac{0.2}{0.2}\right) + 0.95 \times 0.1056$		
$= 0.05 \times 0.8413 + 0.95 \times 0.1056$		
$= 0.142385$	1A	OR 0.1424
(iii) The required probability		
$= \frac{0.05(0.8413)}{0.05(0.8413) + 0.95(1-0.1056)}$	1M+1A	
≈ 0.0472	1A	
	(8)	
(c) (i) The required probability		
$= \frac{C_3^8 C_1^{12} (0.142385)^4 (1-0.142385)^{16}}{C_4^{20} (0.142385)^4 (1-0.142385)^{16}}$	1M	
$= \frac{224}{1615}$	1A	OR 0.1387
(ii) The required probability		
$= \frac{C_2^7 (0.142385)^3 (1-0.142385)^{17} + C_2^7 C_1^{12} (0.142385)^4 (1-0.142385)^{16}}{(1-0.142385)^{20} + C_1^{20}(0.142385)(1-0.142385)^{19} + C_2^{20}(0.142385)^2(1-0.142385)^{18} + C_3^{20}(0.142385)^3(1-0.142385)^{17} + C_4^{20}(0.142385)^4(1-0.142385)^{16}}$	1M+1M+1A	1M for numerator 1M for denominator
≈ 0.0156	1A	
	(6)	

Solution	Marks	Remarks

12. (a) (i) $\dfrac{e^{-\lambda}\lambda^1}{1!}=\dfrac{41.04}{200}$ ——— (1)

$\dfrac{e^{-\lambda}\lambda^4}{4!}=\dfrac{26.72}{200}$ ——— (2)

1A — For both

$(2)\div(1)$:

$\dfrac{\lambda^3}{24}=\dfrac{334}{513}$

$\lambda \approx 2.5$ (correct to 1 decimal place) — 1A

(ii) $a=7.22$, $b=16.42$, $c=51.30$, $d=42.75$, $e=13.36$ — 2A — 1A for any 1 correct; 2A for all correct

(iii) For the number of passengers >5, the expected frequency by Po(2) is

$200-27.07-54.13-54.13-36.09-18.04-7.22=3.32$ — 1M — For either one

For the number of passengers >5, the expected frequency by Po(2.5) is

$200-16.42-41.04-51.30-42.75-26.72-13.36=8.41$

The sum of errors for model fitted by Po(2) is

$$E_1=|28-27.07|+|50-54.13|+|52-54.13|+|40-36.09|+|24-18.04|$$
$$+|6-7.22|+|0-3.32|$$
$$=21.6$$

The sum of errors for model fitted by Po(2.5) is

$$E_2=|28-16.42|+|50-41.04|+|52-51.30|+|40-42.75|+|24-26.72|$$
$$+|6-13.36|+|0-8.41|$$
$$=42.48$$

1A — For both

Since $E_1<E_2$, Po(2) fits the observed data better. — 1A — Follow through

(7)

(b) Let X_i be the number of passengers waiting at the i^{th} stop.

(i) The required probability

$=\mathrm{P}(X_1\geq 4)$

$=1-\dfrac{e^{-2}2^0}{0!}-\dfrac{e^{-2}2^1}{1!}-\dfrac{e^{-2}2^2}{2!}-\dfrac{e^{-2}2^3}{3!}$ — 1M

≈ 0.1429 — 1A

(ii) The required probability

$=\mathrm{P}(X_1\leq 2)\cdot\mathrm{P}(X_2\geq 2)$

$=\left(\dfrac{e^{-2}2^0}{0!}+\dfrac{e^{-2}2^1}{1!}+\dfrac{e^{-2}2^2}{2!}\right)\left(1-\dfrac{e^{-2}2^0}{0!}-\dfrac{e^{-2}2^1}{1!}\right)$ — 1M

≈ 0.4019 — 1A

(iii) The required probability

$=[\mathrm{P}(X_1=1)\cdot\mathrm{P}(X_2=1)+\mathrm{P}(X_1=1)\cdot\mathrm{P}(X_2=2)+\mathrm{P}(X_1=2)\cdot\mathrm{P}(X_2=1)]$

$\cdot[1-\mathrm{P}(X_3=0)]$

$=\left[\left(\dfrac{e^{-2}2^1}{1!}\right)^2+\left(\dfrac{e^{-2}2^1}{1!}\right)\left(\dfrac{e^{-2}2^2}{2!}\right)\times 2\right]\cdot\left(1-\dfrac{e^{-2}2^0}{0!}\right)$ — 1M+1M+1M

1M for $\left(\dfrac{e^{-2}2^1}{1!}\right)^2$

1M for $\left(\dfrac{e^{-2}2^1}{1!}\right)\left(\dfrac{e^{-2}2^2}{2!}\right)\times 2$

1M for $1-\dfrac{e^{-2}2^0}{0!}$

≈ 0.1900 — 1A

(8)