

Section A

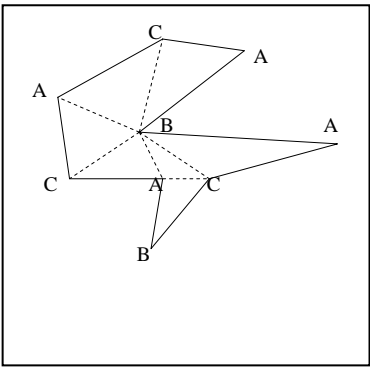
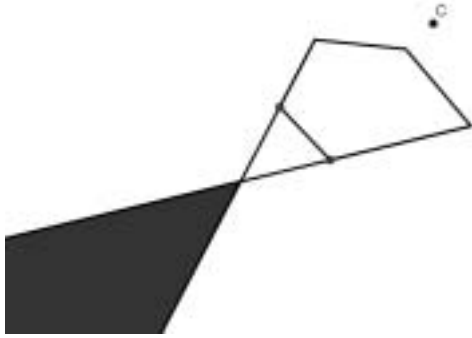
<p>1(i)</p> <table border="1" data-bbox="209 324 788 398"> <tr> <td>x</td> <td>-2</td> <td>-1</td> <td>0</td> <td>1</td> <td>2</td> </tr> <tr> <td>y</td> <td>1.0655</td> <td>1.1696</td> <td>1.4142</td> <td>1.9283</td> <td>2.8964</td> </tr> </table> <p>$A \approx \frac{1}{2} \times 1 \{1.0655 + 2.8964 + 2(1.1696 + 1.4142 + 1.9283)\}$ $= 6.493$</p>	x	-2	-1	0	1	2	y	1.0655	1.1696	1.4142	1.9283	2.8964	<p>B2,1,0 M1 A1 [4]</p>	<p>table values formula 6.5 or better www</p>
x	-2	-1	0	1	2									
y	1.0655	1.1696	1.4142	1.9283	2.8964									
<p>(ii) Smaller, as the trapezium rule is an over-estimate in this case and the error is less with more strips</p>	<p>B1 B1 [2]</p>													
<p>2</p> $x = \frac{1}{1+t} \Rightarrow 1+t = \frac{1}{x}$ $\Rightarrow t = \frac{1}{x} - 1$ $y = \frac{1-t}{1+2t} = \frac{1 - \frac{1}{x} + 1}{1 + \frac{2}{x} - 2}$ $= \frac{2 - \frac{1}{x}}{\frac{2}{x} - 1} = \frac{2x-1}{2-x}$	<p>M1 A1 M1 M1 A1 [5]</p>	<p>attempt to solve for t oe substituting for t in terms of x clearing subsidiary fractions</p>												
<p>3</p> $(3-2x)^{-3} = 3^{-3} \left(1 - \frac{2}{3}x\right)^{-3}$ $= \frac{1}{27} \left(1 + (-3) \left(-\frac{2}{3}x\right) + \frac{(-3)(-4)}{2} \left(-\frac{2}{3}x\right)^2 + \dots\right)$ $= \frac{1}{27} \left(1 + 2x + \frac{8}{3}x^2 + \dots\right)$ $= \frac{1}{27} + \frac{2}{27}x + \frac{8}{81}x^2 + \dots$ <p>Valid for $-1 < -\frac{2}{3}x < 1$</p> $\Rightarrow -\frac{3}{2} < x < \frac{3}{2}$	<p>M1 B1 B2,1,0 A1 M1 A1 [7]</p>	<p>dealing with the '3' correct binomial coeffs 1, 2, 8/3 oe cao</p>												

<p>4(i) $\overline{AB} = \begin{pmatrix} 2 \\ 3 \\ -5 \end{pmatrix}, \overline{BC} = \begin{pmatrix} 5 \\ 0 \\ 2 \end{pmatrix}$</p> $\overline{AB} \cdot \overline{BC} = \begin{pmatrix} 2 \\ 3 \\ -5 \end{pmatrix} \cdot \begin{pmatrix} 5 \\ 0 \\ 2 \end{pmatrix} = 2 \times 5 + 3 \times 0 + (-5) \times 2 = 0$ <p>\Rightarrow AB is perpendicular to BC.</p>	<p>B1 B1</p> <p>M1E1</p> <p>[4]</p>	
<p>(ii) $AB = \sqrt{2^2 + 3^2 + (-5)^2} = \sqrt{38}$ $BC = \sqrt{5^2 + 0^2 + 2^2} = \sqrt{29}$ $\text{Area} = \frac{1}{2} \times \sqrt{38} \times \sqrt{29} = \frac{1}{2} \sqrt{1102}$ or 16.6 units²</p>	<p>M1 B1 A1 [3]</p>	<p>complete method ft lengths of both AB, BC oe www</p>
<p>5 $\text{LHS} = \frac{2 \sin \theta \cos \theta}{1 + 2 \cos^2 \theta - 1}$ $= \frac{2 \sin \theta \cos \theta}{2 \cos^2 \theta}$ $= \frac{\sin \theta}{\cos \theta} = \tan \theta = \text{RHS}$</p>	<p>M1 M1 E1 [3]</p>	<p>one correct double angle formula used cancelling cos θs</p>
<p>6(i) $\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} -8 - 3\lambda \\ -2 \\ 6 + \lambda \end{pmatrix}$</p> <p>Substituting into plane equation: $2(-8 - 3\lambda) - 3(-2) + 6 + \lambda = 11$ $\Rightarrow -16 - 6\lambda + 6 + 6 + \lambda = 11$ $\Rightarrow 5\lambda = -15, \lambda = -3$ So point of intersection is (1, -2, 3)</p>	<p>B1</p> <p>M1</p> <p>A1 A1ft [4]</p>	
<p>(ii) Angle between $\begin{pmatrix} 2 \\ -3 \\ 1 \end{pmatrix}$ and $\begin{pmatrix} -3 \\ 0 \\ 1 \end{pmatrix}$</p> $\cos \theta = \frac{2 \times (-3) + (-3) \times 0 + 1 \times 1}{\sqrt{14} \sqrt{10}}$ $= (-)0.423$ <p>\Rightarrow acute angle = 65°</p>	<p>B1</p> <p>M1</p> <p>A1 A1 [4]</p>	<p>allow M1 for a complete method only for any vectors</p>

Section B

<p>7(i) When $t = 0$, $v = 5(1 - e^0) = 0$ As $t \rightarrow \infty$, $e^{-2t} \rightarrow 0$, $\Rightarrow v \rightarrow 5$ When $t = 0.5$, $v = 3.16 \text{ m s}^{-1}$</p>	<p>E1 E1 B1 [3]</p>	
<p>(ii) $\frac{dv}{dt} = 5 \times (-2)e^{-2t} = 10e^{-2t}$ $10 - 2v = 10 - 10(1 - e^{-2t}) = 10e^{-2t}$ $\Rightarrow \frac{dv}{dt} = 10 - 2v$</p>	<p>B1 M1 E1 [3]</p>	
<p>(iii) $\frac{dv}{dt} = 10 - 0.4v^2$ $\Rightarrow \frac{10}{100 - 4v^2} \frac{dv}{dt} = 1$ $\Rightarrow \frac{10}{25 - v^2} \frac{dv}{dt} = 4$ $\Rightarrow \frac{10}{(5-v)(5+v)} \frac{dv}{dt} = 4^*$ $\frac{10}{(5-v)(5+v)} = \frac{A}{5-v} + \frac{B}{5+v}$ $\Rightarrow 10 = A(5+v) + B(5-v)$ $v = 5 \Rightarrow 10 = 10A \Rightarrow A = 1$ $v = -5 \Rightarrow 10 = 10B \Rightarrow B = 1$ $\Rightarrow \frac{10}{(5-v)(5+v)} = \frac{1}{5-v} + \frac{1}{5+v}$ $\Rightarrow \int \left(\frac{1}{5-v} + \frac{1}{5+v} \right) dv = 4 \int dt$ $\Rightarrow \ln(5+v) - \ln(5-v) = 4t + c$ when $t = 0$, $v = 0$, $\Rightarrow 0 = 4 \times 0 + c \Rightarrow c = 0$ $\Rightarrow \ln\left(\frac{5+v}{5-v}\right) = 4t$ $\Rightarrow t = \frac{1}{4} \ln\left(\frac{5+v}{5-v}\right)^*$</p>	<p>M1 E1 M1 A1 M1 A1 A1 E1 [8]</p>	<p>for both $A=1, B=1$ separating variables correctly and indicating integration ft their A, B, condone absence of c ft finding c from an expression of correct form</p>
<p>(iv) When $t \rightarrow \infty$, $e^{-4t} \rightarrow 0$, $\Rightarrow v \rightarrow 5/1 = 5$ when $t = 0.5$, $t = \frac{5(1 - e^{-2})}{1 + e^{-2}} = 3.8 \text{ m s}^{-1}$</p>	<p>E1 M1A1 [3]</p>	
<p>(v) The first model</p>	<p>E1 [1]</p>	<p>www</p>

<p>8(i) $AC = 5\sec \alpha$</p> <p>$\Rightarrow CF = AC \tan \beta$ $= 5\sec \alpha \tan \beta$</p> <p>$\Rightarrow GF = 2CF = 10\sec \alpha \tan \beta^*$</p>	<p>B1</p> <p>M1</p> <p>E1</p> <p>[3]</p>	<p>oe</p> <p>$AC \tan \beta$</p>
<p>(ii) $CE = BE - BC$ $= 5 \tan(\alpha + \beta) - 5 \tan \alpha$ $= 5(\tan(\alpha + \beta) - \tan \alpha)$ $= 5\left(\frac{\tan \alpha + \tan \beta}{1 - \tan \alpha \tan \beta} - \tan \alpha\right)$ $= 5\left(\frac{\tan \alpha + \tan \beta - \tan \alpha + \tan^2 \alpha \tan \beta}{1 - \tan \alpha \tan \beta}\right)$ $= \frac{5(1 + \tan^2 \alpha) \tan \beta}{1 - \tan \alpha \tan \beta}$ $= \frac{5 \tan \beta \sec^2 \alpha}{1 - \tan \alpha \tan \beta}^*$</p>	<p>E1</p> <p>M1</p> <p>M1</p> <p>DM1</p> <p>E1</p> <p>[5]</p>	<p>compound angle formula</p> <p>combining fractions</p> <p>$\sec^2 = 1 + \tan^2$</p>
<p>(iii) $\sec^2 45^\circ = 2, \tan 45^\circ = 1$</p> <p>$\Rightarrow CE = \frac{5t \times 2}{1-t} = \frac{10t}{1-t}$</p> <p>$CD = \frac{10t}{1+t}$</p> <p>$\Rightarrow DE = \frac{10t}{1-t} + \frac{10t}{1+t} = 10t\left(\frac{1}{1-t} + \frac{1}{1+t}\right)$ $= 10t\left(\frac{1+t+1-t}{(1-t)(1+t)}\right) = \frac{20t}{1-t^2}^*$</p>	<p>B1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>E1</p> <p>[5]</p>	<p>used</p> <p>substitution for both in CE or CD oe</p> <p>for both</p> <p>adding their CE and CD</p>
<p>(iv) $\cos 45^\circ = 1/\sqrt{2} \Rightarrow \sec \alpha = \sqrt{2}$</p> <p>$\Rightarrow GF = 10\sqrt{2} \tan \beta = 10\sqrt{2} t$</p>	<p>M1</p> <p>E1</p> <p>[2]</p>	
<p>(v) $DE = 2GF$</p> <p>$\Rightarrow \frac{20t}{1-t^2} = 20\sqrt{2}t$</p> <p>$\Rightarrow 1 - t^2 = 1/\sqrt{2} \Rightarrow t^2 = 1 - 1/\sqrt{2}^*$</p> <p>$\Rightarrow t = 0.541$</p> <p>$\Rightarrow \beta = 28.4^\circ$</p>	<p>E1</p> <p>M1</p> <p>A1</p> <p>[3]</p>	<p>invtan t</p>

Qn	Answer	Marks												
1(i)	6 correct marks	B1												
1(ii)	Either state both m and n odd or give a diagram (doorways between rooms not necessary) justification	B1 B1ft												
2(i)	$\frac{9-1}{4} = 2 = \left\lfloor \frac{4+1}{2} \right\rfloor$	B2 (B1 for LHS correct)												
2(ii)	<table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td style="padding: 5px;">x</td> <td style="padding: 5px;">1</td> <td style="padding: 5px;">2</td> <td style="padding: 5px;">3</td> <td style="padding: 5px;">4</td> <td style="padding: 5px;">5</td> </tr> <tr> <td style="padding: 5px;">$\left\lfloor \frac{x}{2} \right\rfloor$</td> <td style="padding: 5px;">1</td> <td style="padding: 5px;">1</td> <td style="padding: 5px;">2</td> <td style="padding: 5px;">2</td> <td style="padding: 5px;">3</td> </tr> </table>	x	1	2	3	4	5	$\left\lfloor \frac{x}{2} \right\rfloor$	1	1	2	2	3	B2,1,0
x	1	2	3	4	5									
$\left\lfloor \frac{x}{2} \right\rfloor$	1	1	2	2	3									
3.	If each of A, B and C appeared at least four times then the total number of vertices would have to be at least $3 \times 4 = 12$	E2												
4(i)		M1 allow if one error A1												
4(ii)	Two points labelled B above clearly marked (or f.t. from (i))	A1												
5(i)	True. Two cameras at the vertices labelled A or at the vertices labelled B would cover the entire gallery	A1 M1 for either												
5(ii)	False. One camera at either vertex labelled A would be sufficient (or C on RHS)	A1 M1												
6	Anywhere in shaded region  <p style="text-align: center;">correct construction</p> <p style="text-align: center;">correct shading</p>	M1 A1												