Section A

1. (a) $\mathrm{M}\left(6,-3\right)$ ***A1A1***

[2 marks]

(b) gradient of [PQ] = $-\dfrac{5}{9}$ ***(A1)***

gradient of L = $\dfrac{9}{5}$ ***A1***

[2 marks]

(c) $y+3=\dfrac{9}{5}(x-6)$ OR $y=\dfrac{9}{5}x-\dfrac{69}{5}$ (or equivalent) ***A1***

> **Note**: Do not accept $L=\dfrac{9}{5}x-\dfrac{69}{5}$.

[1 mark]

Total [5 marks]

Section A

1. (a) attempts to find perimeter *(M1)*

$\text{arc} + 2 \times \text{radius}$ OR $10 + 4 + 4$

$= 18 \text{ (cm)}$ ***A1***

[2 marks]

(b) $10 = 4\theta$ ***(A1)***

$\theta = \frac{10}{4} \left(= \frac{5}{2}, 2.5 \right)$ ***A1***

[2 marks]

(c) area $= \frac{1}{2}\left(\frac{10}{4}\right)\left(4^2\right) \; \left(= 1.25 \times 16\right)$ ***(A1)***

$= 20 \text{ (cm}^2\text{)}$ ***A1***

[2 marks]

Total [6 marks]

3. (a) (i) $x=2$ ***A1***

(ii) $y=1$ ***A1***

[2 marks]

(b) (i) $\left(0,\frac{3}{2}\right)$ ***A1***

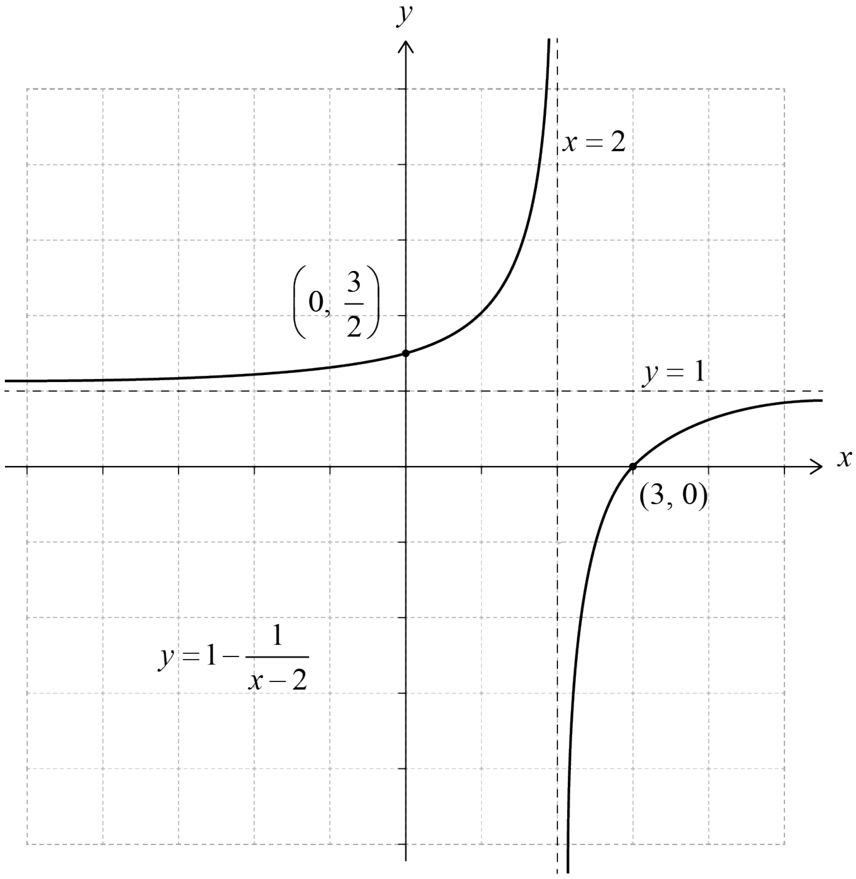
(ii) $(3,0)$ ***A1***

[2 marks]

continued…

Question 3 continued

(c)



two correct branches with correct asymptotic behaviour and intercepts clearly shown ***A1***

[1 mark]

Total [5 marks]

2. (a) recognizing $f(x)=0$ ***(M1)***

$x=-1$ ***A1***

[2 marks]

(b) (i) $x=2$ (must be an equation with x) ***A1***

(ii) $y=\frac{7}{2}$ (must be an equation with y) ***A1***

[2 marks]

(c) **EITHER**

interchanging x and y ***(M1)***

$2xy-4x=7y+7$

correct working with y terms on the same side: $2xy-7y=4x+7$ ***(A1)***

OR

$2yx-4y=7x+7$

correct working with x terms on the same side: $2yx-7x=4y+7$ ***(A1)***

interchanging x and y OR making x the subject $x=\frac{4y+7}{2y-7}$ ***(M1)***

THEN

$f^{-1}(x)=\frac{4x+7}{2x-7}$ (or equivalent) $\left(x\neq\frac{7}{2}\right)$ ***A1***

[3 marks]

Total [7 marks]

3. (a) (i) summing frequencies of riders or finding complement ***(M1)***

probability $= \frac{34}{40}$ ***A1***

(ii) attempt to find expected value ***(M1)***

$\frac{16}{40}+\left(2\times\frac{13}{40}\right)+\left(3\times\frac{2}{40}\right)+\left(4\times\frac{3}{40}\right)$

$\frac{60}{40}(=1.5)$ ***A1***

[4 marks]

(b) evidence of **their** rides/visitor $\times 1000$ or $\div 10$ ***(M1)***

1500 OR 0.15

150 (times) ***A1***

[2 marks]

Total [6 marks]

5. recognition of quadratic in e^x ***(M1)***

$\left(\mathrm{e}^x\right)^2 - 3\mathrm{e}^x + \ln k\left(=0\right)$ OR $A^2 - 3A + \ln k\left(=0\right)$

recognizing discriminant ≥ 0 (seen anywhere) (***M1)***

$\left(-3\right)^2 - 4(1)(\ln k)$ OR $9 - 4\ln k$ ***(A1)***

$\ln k \le \dfrac{9}{4}$ ***(A1)***

$\mathrm{e}^{9/4}$ (seen anywhere) ***A1***

$0 < k \le \mathrm{e}^{9/4}$ ***A1***

[6 marks]

Section B

7. (a) $x=-2$ (must be an equation) ***A1***

[1 mark]

(b) $h=-2$, $k=-5$ ***A1A1***

[2 marks]

(c) substituting $x=0$ into $f(x)$ ***(M1)***

$y=\frac{1}{4}(0+2)^2-5$

$y=-4$ (accept $\mathrm{P}(0,-4)$) ***A1***

[2 marks]

(d) $f'(x)=\frac{1}{2}(x+2)\left(=\frac{1}{2}x+1\right)$ ***(A1)***

substituting $x=0$ into their derivative ***(M1)***

$f'(0)=1$

gradient of normal is -1 (may be seen in their equation) ***A1***

$y=-x-4$ (accept $a=-1$, $b=-4$) ***A1***

Note: Award ***A0*** for $L=-x-4$ (without the $y=$).

[4 marks]

continued…

Question 7 continued

(e) equating their $f(x)$ to their L ***(M1)***

$\frac{1}{4}(x+2)^2 - 5 = -x - 4$

$\frac{1}{4}x^2 + 2x = 0$ (or equivalent) ***(A1)***

valid attempt to solve their quadratic ***(M1)***

$\frac{1}{4}x(x+8) = 0$ OR $x(x+8) = 0$

$x = -8$ ***A1***

Note: Accept both solutions $x = -8$ and $x = 0$ here, $x = -8$ may be seen in working to find coordinates of Q or distance.

substituting their value of x (not $x = 0$) into their $f(x)$ or their L ***(M1)***

$y = -(-8) - 4$ or $y = \frac{1}{4}(-8+2)^2 - 5$

$\mathrm{Q}(-8, 4)$ ***A1***

correct substitution into distance formula ***(A1)***

$\sqrt{(-8-0)^2 + (4-(-4))^2}$

$\text{distance} = \sqrt{128}$ $(= 8\sqrt{2})$ ***A1***

[8 marks]

Total [17 marks]

8. (a) (i) recognition that $n = 5$ ***(M1)***

$S_5 = 45$ ***A1***

(ii) **METHOD 1**

recognition that $S_5 + u_6 = S_6$ ***(M1)***

$u_6 = 15$ ***A1***

METHOD 2

recognition that $60 = \frac{6}{2}(S_1 + u_6)$ ***(M1)***

$60 = 3(5 + u_6)$

$u_6 = 15$ ***A1***

METHOD 3

substituting their u_1 and d values into $u_1 + (n-1)d$ ***(M1)***

$u_6 = 15$ ***A1***

[4 marks]

(b) recognition that $u_1 = S_1$ (may be seen in (a)) OR substituting their u_6 into S_6 ***(M1)***

OR equations for S_5 and S_6 in terms of u_1 and d

$1 + 4$ OR $60 = \frac{6}{2}(u_1 + 15)$

$u_1 = 5$ ***A1***

[2 marks]

continued…

Question 8 continued

(c) **EITHER**

valid attempt to find d (may be seen in (a) or (b)) ***(M1)***

$d = 2$ ***(A1)***

OR

valid attempt to find $S_n - S_{n-1}$ ***(M1)***

$n^2 + 4n - \left(n^2 - 2n + 1 + 4n - 4\right)$ ***(A1)***

OR

equating $n^2 + 4n = \frac{n}{2}\left(5 + u_n\right)$ ***(M1)***

$2n + 8 = 5 + u_n$ (or equivalent) ***(A1)***

THEN

$u_n = 5 + 2(n-1)$ OR $u_n = 2n + 3$ ***A1***

[3 marks]

(d) recognition that $v_2 r^2 = v_4$ OR $\left(v_3\right)^2 = v_2 \times v_4$ ***(M1)***

$r^2 = 3$ OR $v_3 = (\pm)5\sqrt{3}$ ***(A1)***

$r = \pm\sqrt{3}$ ***A1***

Note: If no working shown, award ***M1A1A0*** for $\sqrt{3}$.

[3 marks]

(e) recognition that r is negative ***(M1)***

$v_5 = -15\sqrt{3}$ $\left(= -\frac{45}{\sqrt{3}}\right)$ ***A1***

[2 marks]

Total [14 marks]

9. (a) $y^2 = 9 - x^2$ OR $y = \pm\sqrt{9 - x^2}$ ***A1***

(since $y > 0$) $\Rightarrow y = \sqrt{9 - x^2}$ ***AG***

[1 mark]

(b) $b = 2y$ $\left(= 2\sqrt{9 - x^2}\right)$ or $h = x + 3$ ***(A1)***

attempts to substitute their base expression and height expression into $A = \dfrac{1}{2}bh$ ***(M1)***

$A = \sqrt{9 - x^2}\,(x + 3)$ (or equivalent) $\left(= \dfrac{2(x+3)\sqrt{9 - x^2}}{2} = x\sqrt{9 - x^2} + 3\sqrt{9 - x^2}\right)$ ***A1***

[3 marks]

(c) attempts to use the product rule to find $\dfrac{\mathrm{d}A}{\mathrm{d}x}$ ***(M1)***

attempts to use the chain rule to find $\dfrac{\mathrm{d}}{\mathrm{d}x}\sqrt{9 - x^2}$ ***(M1)***

$\left(\dfrac{\mathrm{d}A}{\mathrm{d}x} =\right) \sqrt{9 - x^2} + (3 + x)\left(\dfrac{1}{2}\right)\left(9 - x^2\right)^{-\frac{1}{2}}(-2x)$ $\left(= \sqrt{9 - x^2} - \dfrac{x^2 + 3x}{\sqrt{9 - x^2}}\right)$ ***A1***

$\left(\dfrac{\mathrm{d}A}{\mathrm{d}x} =\right) \dfrac{9 - x^2}{\sqrt{9 - x^2}} - \dfrac{x^2 + 3x}{\sqrt{9 - x^2}}$ $\left(= \dfrac{9 - x^2 - \left(x^2 + 3x\right)}{\sqrt{9 - x^2}}\right)$ ***A1***

$\dfrac{\mathrm{d}A}{\mathrm{d}x} = \dfrac{9 - 3x - 2x^2}{\sqrt{9 - x^2}}$ ***AG***

[4 marks]

continued…

Question 9 continued

(d) $\frac{\mathrm{d}A}{\mathrm{d}x}=0\ \left(\frac{9-3x-2x^2}{\sqrt{9-x^2}}=0\right)$ ***(M1)***

attempts to solve $9-3x-2x^2=0$ (or equivalent) ***(M1)***

$-(2x-3)(x+3)\left(=0\right)$ OR $x=\frac{3\pm\sqrt{(-3)^2-4(-2)(9)}}{2(-2)}$ (or equivalent) ***(A1)***

$x=\frac{3}{2}$ ***A1***

Note: Award the above ***A1*** if $x=-3$ is also given.

substitutes their value of x into either $y=\sqrt{9-x^2}$ or $y=-\sqrt{9-x^2}$ ***(M1)***

Note: Do not award the above ***(M1)*** if $x\le 0$.

$y=-\sqrt{9-\left(\frac{3}{2}\right)^2}$

$=-\frac{\sqrt{27}}{2}\left(=-\frac{3\sqrt{3}}{2},=-\sqrt{\frac{27}{4}},=-\sqrt{6.75}\right)$ ***A1***

[6 marks]

Total [14 marks]