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1 (i) \[ \frac{1}{3} \] \hspace{1cm} B1 1

(ii) \[\frac{1}{9^\frac{1}{2}} \text{ or } \frac{1}{\sqrt{9}} \text{ soi} \] \hspace{1cm} A1 2 \[ \frac{2}{3} \]

2 (i) Reasonably correct curve for \( y = -\frac{1}{x^2} \) in 3rd and 4th quadrants only

B1* \[ \text{dep*} \] 2 Very good curves in curve for \( y = -\frac{1}{x^2} \) in 3rd and 4th quadrants

SC If 0, very good single curve in either 3rd or 4th quadrant and nothing in other three quadrants. B1

(ii) Translation of their \( y = -\frac{1}{x^2} \) vertically

A1 2 Reasonably correct curve, horizontal asymptote soi at \( y = 3 \)

(iii) \( y = -\frac{2}{x^2} \) \hspace{1cm} B1 1

\[ \frac{12(3 - \sqrt{5})}{(3 + \sqrt{5})(3 - \sqrt{5})} = \frac{12(3 - \sqrt{5})}{9 - 5} = 9 - 3\sqrt{5} \]

\[ \text{M1} \] \hspace{1cm} \[ \text{A1} \] 3

\[ 3\sqrt{2} - \sqrt{2} = 2\sqrt{2} \] \hspace{1cm} M1 Attempt to express \( \sqrt{18} \) as \( k\sqrt{2} \)

\[ \text{A1} \] 2 \[ \frac{5}{5} \]
4 (i) \((x^2 - 4x + 4)(x + 1)\)  
\[= x^3 - 3x^2 + 4\]  
**M1** Attempt to multiply a 3 term quadratic by a linear factor or to expand all 3 brackets with an appropriate number of terms (including an \(x^3\) term)  
**A1** Expansion with at most 1 incorrect term  
**A1** 3 Correct, simplified answer  

(ii)  
\[k = x^2\]  
\[4k^2 + 3k - 1 = 0\]  
\[(4k - 1)(k + 1) = 0\]  
\[k = \frac{1}{4}\] (or \(k = -1\))  
\[x = \pm \frac{1}{2}\]  
**M1** Use a substitution to obtain a quadratic or factorise into 2 brackets each containing \(x^2\)  
Correct method to solve a quadratic  
**A1** Attempt to square root to obtain \(x\)  
\[\pm \frac{1}{2}\] and no other values  
5  
\[y = 2x + 6x^{\frac{1}{2}}\]  
\[\frac{dy}{dx} = 2 - 3x^{\frac{3}{2}}\]  
When \(x = 4\), gradient \[= 2 - \frac{3}{\sqrt{4^3}}\] \[= \frac{13}{8}\]  
**M1** Correct evaluation of either \(2 - \frac{3}{4^2}\) or \(2 - 3\) \[\frac{1}{2}\]  
**A1** 5  

7  
\[2(6 - 2y)^2 + y^2 = 57\]  
\[2(36 - 24y + 4y^2) + y^2 = 57\]  
\[9y^2 - 48y + 15 = 0\]  
\[3y^2 - 16y + 5 = 0\]  
\[(3y - 1)(y - 5) = 0\]  
\[y = \frac{1}{3}\] or \(y = 5\)  
\[x = \frac{16}{3}\] or \(x = -4\)  
**M1** substitute for \(x/y\) or attempt to get an equation in 1 variable only  
Correct unsimplified expression  
**A1** obtain correct 3 term quadratic  
**M1** correct method to solve 3 term quadratic  
**A1** 6 SC If \(A0\) \(A0\), one correct pair of values, spotted or from correct factorisation **www** **B1**
8 (i) \[ 2(x^2 + \frac{5}{2}x) = 2\left[ \left( x + \frac{5}{4} \right)^2 - \frac{25}{16} \right] = 2\left( x + \frac{5}{4} \right)^2 - \frac{25}{8} \]

\[
= 2\left( x + \frac{5}{4} \right)^2 - \frac{25}{8}
\]

\[
q = -2p^2
\]

\[
A1 \quad q = -\frac{25}{8} \text{ c.w.o.}
\]

(ii) \[
\left( -\frac{5}{4}, -\frac{25}{8} \right)
\]

\[
\text{B1} \quad \text{B1}\sqrt{2}
\]

(iii) \[ x = -\frac{5}{4} \]

\[
\text{B1} \quad 1
\]

(iv) \[ x(2x + 5) > 0 \]

\[
0, \quad -\frac{5}{2}
\]

\[
\text{M1} \quad \text{Correct method to find roots}
\]

\[
\text{A1} \quad \text{0, } -\frac{5}{2} \text{ seen}
\]

\[ x < -\frac{5}{2}, x > 0 \]

\[
\text{M1} \quad \text{Correct method to solve quadratic inequality.}
\]

\[
\text{A1} \quad 4 \text{ [10]}
\]

9 (i) \[
\frac{4 + p}{2} = -1, \quad \frac{5 + q}{2} = 3
\]

\[
p = -6
\]

\[
q = 1
\]

\[
\text{M1} \quad \text{Correct method (may be implied by one correct coordinate)}
\]

\[
\text{A1} \quad \text{Correct method to solve quadratic inequality.}
\]

\[
\text{A1} \quad 3
\]

(ii) \[
r^2 = (4 - 1)^2 + (5 - 3)^2
\]

\[
r = \sqrt{29}
\]

\[
\text{M1} \quad \text{Use of } \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \text{ for either radius or diameter}
\]

\[
\text{A1} \quad 2
\]

(iii) \[ (x + 1)^2 + (y - 3)^2 = 29 \]

\[ x^2 + y^2 + 2x - 6y - 19 = 0 \]

\[
\text{M1} \quad (x + 1)^2 + (y - 3)^2 \text{ seen}
\]

\[
(x \pm 1)^2 + (y \pm 3)^2 = \text{their } r^2
\]

\[
\text{A1} \quad 3 \text{ Correct equation in correct form}
\]

(iv) \[
\text{gradient of radius } = \frac{3 - 5}{-1 - 4} = \frac{2}{5}
\]

\[
\text{gradient of tangent } = -\frac{5}{2}
\]

\[
\text{B1}\sqrt{2} \quad \text{oe}
\]

\[
y - 5 = -\frac{5}{2}(x - 4)
\]

\[
y = -\frac{5}{2}x + 15
\]

\[
\text{M1} \quad \text{Correct equation of straight line through (4, 5), any non-zero gradient}
\]

\[
\text{A1} \quad 5 \text{ [3]}
\]

\[
\text{oe 3 term equation e.g. } 5x + 2y = 30
\]
10(i) \( \frac{dy}{dx} = 6x^2 + 10x - 4 \)
\[ 6x^2 + 10x - 4 = 0 \]
\[ 2(3x^2 + 5x - 2) = 0 \]
\[ (3x-1)(x+2) = 0 \]
\[ x = \frac{1}{3} \text{ or } x = -2 \]
\[ y = -\frac{19}{27} \text{ or } y = 12 \]

B1 1 term correct
B1 Completely correct (no +c)
M1* Sets their \( \frac{dy}{dx} = 0 \)
M1 dep* Correct method to solve quadratic

A1 SC If A0 A0, one correct pair of values, spotted or from correct factorisation www B1

(ii) \(-2 < x < \frac{1}{3}\)

M1 Any inequality (or inequalities) involving both their \( x \) values from part (i)
A1 2 Allow \( \leq \) and \( \geq \)

(iii) When \( x = \frac{1}{2} \), \( 6x^2 + 10x - 4 = \frac{5}{2} \)
\[ 2x^3 + 5x^2 - 4x = -\frac{1}{2} \]
\[ y + \frac{1}{2} = \frac{5}{2} \left( x - \frac{1}{2} \right) \]
\[ 10x - 4y - 7 = 0 \]

M1 Substitute \( x = \frac{1}{2} \) into their \( \frac{dy}{dx} \)
B1 Correct \( y \) coordinate

M1 Correct equation of straight line using their values. Must use their \( \frac{dy}{dx} \) value not e.g. the negative reciprocal
A1 Shows rearrangement to given equation 
CWO throughout for A1

(iv) B1 Sketch of a cubic with a tangent which meets it at 2 points only

B1 2 +ve cubic with max/min points and line with +ve gradient as tangent to the curve to the right of the min

SC1 B1 Convincing algebra to show that the cubic
\[ 8x^3 + 20x^2 - 26x + 7 = 0 \]
\[ (2x-1)(2x-1)(x+7) \]
B1 Correct argument to say there are 2 distinct roots
SC2 B1 Recognising \( y = 2.5x -7/4 \) is tangent from part (iii)
B1 As second B1 on main scheme