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| 1 | ${ }^{9} \mathrm{C}_{6}$ or ${ }^{9} \mathrm{C}_{3}$ used $\left(\frac{1}{x^{2}}\right)^{3}$ seen $-84$ | M1 <br> B1 <br> A1 | [3] | Correct answer only $\Rightarrow 3$ marks |
| :---: | :---: | :---: | :---: | :---: |
| 2 | (i) $(31 / 2,2)$ $\text { (ii) } \begin{aligned} & m=\frac{-1-5}{5-2}=-2 \\ & y-6=\frac{-1}{m}(x-8) \\ & x-2 y+4=0 \end{aligned}$ | $\begin{aligned} & \text { B1 } \\ & \text { B1 } \\ & \text { M1 } \\ & \text { A1 } \end{aligned}$ | [1] | Use of $m_{1} m_{2}=-1$ and $y-k=m(x-h)$ Accept any form |
| 3 | $\begin{aligned} & 15 \cos ^{2} x+\cos x-2=0 \\ & (5 \cos x+2)(3 \cos x-1)=0 \\ & 113(.6), 70.5 \end{aligned}$ | M1 <br> M1 <br> A1A1 | [4] | $1-\cos ^{2} x=\sin ^{2} x \&$ attempt simplify Attempt to solve 3-term quadratic for $\cos x$ <br> SC 1.98, 1.23 scores $1 / 2$ |
| 4 | (i) Correct sine curve <br> (ii) Required line $y=1-\frac{x}{\pi}$ Line through $(0,1),(\pi, 0)$ drawn 3 roots | B1 <br> B1 <br> B1 <br> B1 $\sqrt{ }$ | [1] | 2 shown or implied <br> SC B1 for correct graphs without 1 or 2 marked ft on trig curve and line |
| 5 | (i) $\begin{aligned} & \frac{\mathrm{d} y}{\mathrm{~d} x}=\frac{-1}{(x-3)^{2}}+1 \\ & \frac{\mathrm{~d}^{2} y}{\mathrm{~d} x^{2}}=\frac{2}{(x-3)^{3}} \end{aligned}$ <br> (ii) $(x-3)^{2}=1 \Rightarrow x-3= \pm 1$ $\begin{aligned} & x=4,2 \\ & y=5,1 \end{aligned}$ <br> When $x=4 \frac{\mathrm{~d}^{2} y}{\mathrm{~d} x^{2}}>0(=2) \Rightarrow \min$ <br> When $x=2 \frac{\mathrm{~d}^{2} y}{\mathrm{~d} x^{2}}<0(=-2) \Rightarrow \max$ | B1 <br> B1 <br> M1 <br> A1 <br> A1 <br> M1 <br> A1 | [2] | oe <br> oe <br> Set $\frac{\mathrm{d} y}{\mathrm{~d} x}=0 \&$ reasonable attempt to solve <br> Investigate signs of $\mathrm{f}^{\prime \prime}$ at a point or other method |

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\begin{tabular}{|c|c|c|c|c|}
\hline 6 \& \begin{tabular}{l}
(i)
\[
\begin{aligned}
\& (3 x+5)(x-1)(>0) \\
\& -5 / 3,1 \\
\& x<-5 / 3, x>1
\end{aligned}
\] \\
(ii)
\[
\begin{aligned}
\& \mathrm{f}(x)=x^{3}+x^{2}-5 x(+c) \\
\& 3=1+1-5+c \\
\& \mathrm{f}(x)=x^{3}+x^{2}-5 x+6
\end{aligned}
\]
\end{tabular} \& \[
\begin{array}{|l}
\hline \text { M1 } \\
\text { A1 } \\
\text { A1 } \\
\\
\text { M1 } \\
\text { A1 } \\
\text { M1 } \\
\text { A1 }
\end{array}
\] \& [3] \& \begin{tabular}{l}
Attempt at factorisation \\
Both required \\
Ignore any words between answers \\
Condone < > \\
Attempt at integration \\
Any unsimplified expression ok \\
Sub. (1, 3) \\
Accept \(c=6\)
\end{tabular} \\
\hline 7 \& \begin{tabular}{l}
(i) Range is \(0<\mathrm{f}(x)<4, \quad 0\) to 4 \\
(ii) \(y=x\) drawn or implied Correct sketch of \(\mathrm{f}^{-1}\) \\
(iii)
\[
\begin{aligned}
\& (x \mapsto) \sqrt{2 x} \text { for } 0<x<2 \\
\& (x \mapsto) 2 x-2 \text { for } 2<x<4
\end{aligned}
\]
\end{tabular} \& \begin{tabular}{l}
B1 \\
B1 \\
B1 \\
B1B1 \\
B1B1
\end{tabular} \& [1]
[2]

[4] \& | Accept in two parts. Condone < |
| :--- |
| SC if f missing, $(2,2)(4,6)$ must be shown |
| Condone \ll | \\

\hline 8 \& $$
\text { (i) } \begin{array}{ll}
\hline & 1 / 2 \times 5^{2} \times 1.2 \\
& 1 / 2 \times 5^{2} \times \sin 1.2 \\
& 2\left[1 / 2 \times 5^{2} \times 1.2-1 / 2 \times 5^{2} \times \sin 1.2\right] \\
& 6.70
\end{array}
$$

\[
$$
\begin{array}{|ll}
\text { (ii) } & 5 \cos 0.6 \\
& 5-" 5 \cos 0.6 " \\
& 10(1-\cos 0.6) \\
& 1.75
\end{array}
$$

\] \& | B1 |
| :--- |
| B1 |
| M1 |
| A1 |
| M1 |
| M1 |
| M1 |
| A1 | \& [4]

[4] \& | Subtraction and multiplication by 2 |
| :--- |
| Accept 6.7 or anything rounding to 6.70 |
| Subtraction from 5 |
| Multiplication by 2 | \\

\hline 9 \& | (a) $\begin{aligned} & \frac{100}{1-r}=2000 \\ & r=19 / 20 \\ & a r=95 \end{aligned}$ |
| :--- |
| (b) (i) $\begin{aligned} & a+2 d=90, a+4 d=80 \\ & d=-5, a=100 \end{aligned}$ |
| (ii) $\begin{aligned} & a+m d=0 \\ & m=20 \end{aligned}$ |
| (iii) $\begin{aligned} & \frac{n}{2}[200+(n-1)(-5)]=0 \\ & n=41 \end{aligned}$ | \& M1

A1
A1 $\sqrt{ }$
B1B1
M1
A1
M1
A1 \& $[3]$
$[2]$
$[2]$

[2] \& | Correct formula and attempt to solve |
| :--- |
| For $100 \times r$ |
| Or use correct sum formula $m=20$ with no working scores 2 |
| $n=41$ with no working scores 2 Do not penalise $n=0$ | \\

\hline
\end{tabular}

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\begin{tabular}{|c|c|c|c|c|}
\hline 10 \& \begin{tabular}{l}
(i) \(\overrightarrow{O A} \cdot \overrightarrow{O B}=-6+2+12=8\)
\[
\begin{aligned}
\& \cos A O B=\frac{8}{\sqrt{14} \sqrt{29}} \\
\& A O B=66.6^{\circ}
\end{aligned}
\] \\
(ii) \(3 \mathbf{i}-2 \mathbf{j}+4 \mathbf{k}+p(2 \mathbf{i}+\mathbf{j}-3 \mathbf{k})\) \\
(iii) \(\overrightarrow{B C}=\mathbf{i}(3+2 p)+\mathbf{j}(-2+p)+\mathbf{k}(4-3 p)\) \\
Their \(\overrightarrow{B C} \cdot[2 \mathbf{i}+\mathbf{j}-3 \mathbf{k}]=0\)
\[
\begin{aligned}
\& 2(3+2 p)+(p-2)-3(4-3 p)=0 \\
\& p=4 / 70.571
\end{aligned}
\]
\end{tabular} \&  \& [4]
[1]

[4] \& | Use of $x_{1} x_{2}+y_{1} y_{2}+z_{1} z_{2}$ |
| :--- |
| Mod worked correctly for either one Division of " 8 " by product of mods |
| In any unsimplified form |
| Scalar product $=0$ used |
| ft from their $B C$ |
| cao | \\

\hline 11 \& | (i) $\begin{aligned} & 9-x^{3}=\frac{8}{x^{3}} \\ & x^{6}-9 x^{3}+8=0 \\ & (X-1)(X-8)=0 \rightarrow X=1 \text { or } 8 \\ & a=1, b=2 \end{aligned}$ |
| :--- |
| (ii) $\begin{aligned} & \int_{1}^{2}\left[\left(9-x^{3}\right)-\frac{8}{x^{3}}\right] \mathrm{d} x \\ & {\left[9 x-\frac{x^{4}}{4}\right] \cdot\left[\frac{-4}{x^{2}}\right]} \\ & 18-4+1-\left(9-\frac{1}{4}+4\right) \\ & 2 \frac{1}{4} \end{aligned}$ |
| (iii) $\begin{aligned} & \frac{\mathrm{d} y}{\mathrm{~d} x}=\frac{-24}{x^{4}}, \frac{\mathrm{~d} y}{\mathrm{~d} x}=-3 x^{2} \\ & \frac{-24}{c^{4}}=-3 c^{2} \\ & c^{6}=8 \\ & c=\sqrt{2} \text { or } 8^{1 / 6} \text { or } 1.41(4 \ldots) \end{aligned}$ | \& | M1 |
| :--- |
| A1 |
| M1 |
| A1 |
| M1 |
| M1 |
| B1 |
| B1 |
| M1 |
| A1 |
| B1, B1 |
| M1 |
| A1 | \& [4] \& | Together with attempt to mult by $x^{3}$ |
| :--- |
| AG completely correct working Attempt to solve quadratic in $X$ or $x^{3}$ |
| Intention to integrate the difference $y_{1}-y_{2} \operatorname{not} \pi\left(y_{1}-y_{2}\right)$ |
| Correct use of their limits once |
| cao |
| Equating and solution |
| Accept $x$ or $c$ | \\

\hline
\end{tabular}

