OXFORD AQA
INTERNATIONAL QUALIFICATIONS

INTERNATIONAL A-LEVEL
MATHEMATICS
MA03

(9660/MA03) Unit P2 Pure Mathematics

Mark scheme

June 2025

Version: 0.1 Pre-Standardisation

256XMA03/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from www.oxfordaqa.com

Key to mark scheme abbreviations

M	Mark is for method
m	Mark is dependent on one or more M marks and is for method
A	Mark is dependent on M or m marks and is for accuracy
B	Mark is independent of M or m marks and is for method and accuracy
E	Mark is for explanation
√ **or ft**	Follow through from previous incorrect result
CAO	Correct answer only
CSO	Correct solution only
AWFW	Anything which falls within
AWRT	Anything which rounds to
ACF	Any correct form
AG	Answer given
SC	Special case
oe	Or equivalent
A2, 1	2 or 1 (or 0) accuracy marks
–*x* EE	Deduct *x* marks for each error
NMS	No method shown
PI	Possibly implied
SCA	Substantially correct approach
sf	Significant figure(s)
dp	Decimal place(s)
ISW	Ignore subsequent working

Q	Answer	Marks	Comments
1(a)	<table><tr><th>x</th><th>y</th></tr><tr><td>0.1</td><td>$1-e^{(0.2-0.1^2)}=-0.2092496$</td></tr><tr><td>0.3</td><td>$1-e^{(0.6-0.3^2)}=-0.6652912$</td></tr><tr><td>0.5</td><td>$1-e^{(1-0.5^2)}=-1.117000$</td></tr><tr><td>0.7</td><td>$1-e^{(1.4-0.7^2)}=-1.4843225$</td></tr><tr><td>0.9</td><td>$1-e^{(1.8-0.9^2)}=-1.6912345$</td></tr></table>	B1 M1	All five correct x values (and no extra used) **PI** by five correct y values At least four correct y values in exact form or decimals, rounded or truncated to four dp or better (in table or formula) (**PI** by **AWRT** correct answer)
	$-0.2(0.2092...+0.66529...$ $+1.117...+1.4843...+1.6912...)$	m1	Correct sub into formula with $h=0.2$ **oe** and at least four correct y values either listed, with + signs, or totalled (**PI** by **AWRT** correct answer)
	$=-1.033$	A1	**CAO**, must see this value exactly and no error seen
		4	

Q	Answer	Marks	Comments
1(b)	$\frac{dy}{dx}=-e^{2x-x^2}(2-2x)$	M1	
	$\frac{dy}{dx}=0 \Rightarrow x=1$	A1	
	$(1, 1-e)$	A1	
		3	

	Question 1 Total	**7**	

Q	Answer	Marks	Comments
2(a)	$f(x) = 3\ln x - x^2 + 4x + 5$ $f(5) = 3\ln 5 - 25 + 20 + 5 = 4.8...$ $f(6) = 3\ln 6 - 36 + 24 + 5 = -1.6$	**M1**	Or reverse Both values rounded or truncated to at least 1 sf
	Change of sign, $5 < \alpha < 6$	**A1**	Must have both statement and interval in words or symbols **or** comparing 2 sides: at 5, $3\ln 5 > 0$; at 6, $3\ln 6 < 7$ **M1**: Accuracy as before **A1**: Conclusion as before
		2	

Q	Answer	Marks	Comments
2(b)	$3\ln x + 5 = x^2 - 4x$ $3\ln x + 9 = x^2 - 4x + 4$ $3(3 + \ln x) = (x - 2)^2$	**M1**	
	$x - 2 = \pm\sqrt{3(3 + \ln x)}$ $x = 2 + \sqrt{3(3 + \ln x)}$	**A1**	**AG** Must be convincingly shown, including rejecting the negative solution
		2	

Q	Answer	Marks	Comments
2(c)	$x_2 = 5.719$	**B1**	
	$x_3 = 5.772$	**B1**	**CAO**
		2	

	Question 2 Total	**6**	

Q	Answer	Marks	Comments
3(a)	$[8\sin\theta + 15\cos\theta =]$ $R\sin\theta\cos\alpha + R\cos\theta\sin\alpha$	M1	PI
	$R = 17$	B1	
	$\alpha = 61.9^{\circ}$	A1	**AWRT** 61.9°
	$8\sin\theta + 15\cos\theta = 17\ \sin(\theta + 61.9)$		
		3	

Q	Answer	Marks	Comments
3(b)(i)	0	B1	
		1	

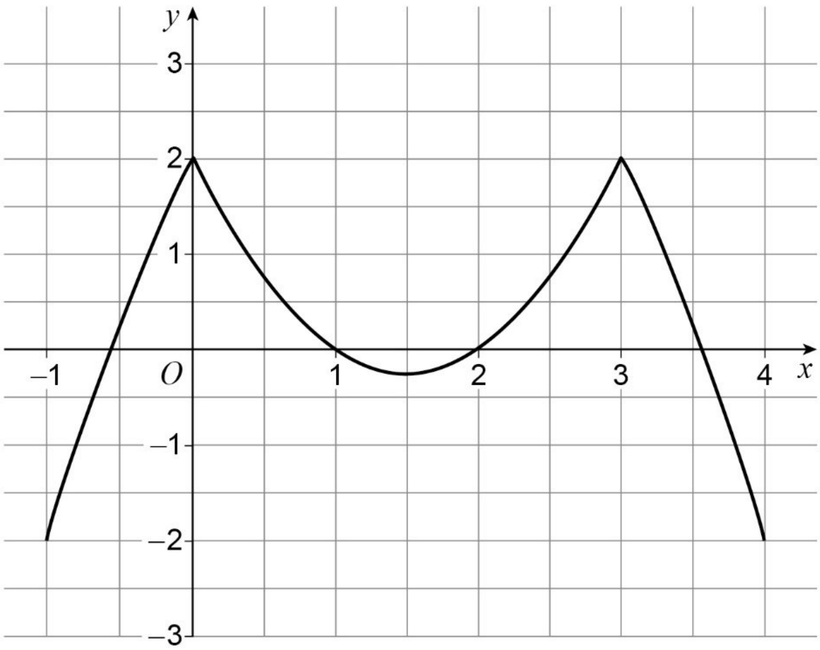
Q	Answer	Marks	Comments
3(b)(ii)	118.1°	B1	
		1	

Q	Answer	Marks	Comments
3(c)	$\text{cosec}^2 Y + \text{cosec}\, Y - 6 = 0$ $(\text{cosec}\, Y + 3)(\text{cosec}\, Y - 2)[= 0]$	M1	Correct use of trig identity **PI**
	$\text{cosec}\, Y = -3, 2$ $\left[\sin Y = -\frac{1}{3}, 0.5\right]$	A1	Both values correct
	$Y = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{13\pi}{6}, \frac{17\pi}{6}, -0.34, 3.481,$ $2\pi - 0.34, 2\pi + 3.481, ...$	A1	For **any** of these values, or rounded or truncated to 2 dp **PI**
	$x = 0.52, 1.57, 0.09, 2.00$	B2,1	**B2**: All 4 correct and no extras in interval (ignore answers outside interval) Condone $\frac{\pi}{6}, \frac{\pi}{2}$ **B1**: 3 correct answers
		5	

	Question 3 Total	**10**	

Q	Answer	Marks	Comments
4(a)(i)	$(1,0)$ and $(2,0)$	B1	
	$\left(\frac{3+\sqrt{17}}{2}, 0\right)$ and $\left(\frac{3-\sqrt{17}}{2}, 0\right)$	B2	Allow 3.30, –0.30 for **B1**
		3	

Q	Answer	Marks	Comments
4(a)(ii)		M1	Symmetrical graph in all 4 quadrants
		A1	'Peaks' and min approx correct



		2	

Q	Answer	Marks	Comments
4(b)	$1 \le x \le 2$ $x \le \dfrac{3-\sqrt{17}}{2}$ $\dfrac{3+\sqrt{17}}{2} \le x$	**B2**	Both correct **B1ft** For one correct
		2	

Q	Answer	Marks	Comments
4(c)	Reflection	**B1**	
	x-axis	**B1**	**oe** Accept rotation through 180°, centre (1.5, 0) for **B1 B1**
		2	

	Question 4 Total	**9**	

Q	Answer	Marks	Comments
5(a)	$(2\times0.5-3)(0.25k-4.5)=R$	M1	One correct substitution
	$(2\times0.5+3)(2\times0.25+0.5k+3)=R$	A1	
	$-0.5k+9=R$ $14+2k=R$	M1	Attempt to solve
	$R=10$ $k=-2$	A1	
		4	

Q	Answer	Marks	Comments
5(b)	$\mathrm{g}(x)=4x^3+2x^2+9$	B1	
	$\dfrac{\mathrm{g}(x)-R}{2x-1}=\dfrac{4x^3+2x^2-1}{2x-1}$	M1	**ft** Their **part (a)**
	$4x^3+2x^2-1=(2x-1)(2x^2+2x+1)$	m1	$\left[\mathrm{g}(x)-R=\right]$ $(2x-1)(ax^2+bx+c)$
	$\left[\dfrac{\mathrm{g}(x)-R}{2x-1}=\right]$ $2x^2+2x+1$	A1	
		4	

	Question 5 Total	8	

Q	Answer	Marks	Comments
6	$y=2\mathrm{f}\left(x+1\right)-4$	M1 A1 A1	**M1**: $y=2\mathrm{f}\left(x\pm a\right)\pm b$ **A1**: $y=2\mathrm{f}\left(x\pm 1\right)\pm 4$ **A1**: All correct

	Question 6 Total	**3**	

Q	Answer	Marks	Comments
7	$\cos^2 x\dfrac{\mathrm{d}y}{\mathrm{d}x}=2-5y$		
	$\int\dfrac{\mathrm{d}y}{2-5y}=\int\dfrac{\mathrm{d}x}{\cos^2 x}=\int\sec^2 x\,\mathrm{d}x$	M1	Separate variables
	$-\dfrac{1}{5}\ln\lvert 2-5y\rvert=\tan x+c$	M1	Correct integration
	$-\dfrac{1}{5}\ln 2=c$	A1	
	$-\dfrac{1}{5}\left(\ln\lvert 2-5y\rvert-\ln 2\right)=\tan x$		
	$\dfrac{2-5y}{2}=\mathrm{e}^{-5\tan x}$	M1	Attempt to isolate y
	$y=\dfrac{2}{5}\left(1-\mathrm{e}^{-5\tan x}\right)$	A1	**ACF**

	Question 7 Total	**5**	

Q	Answer	Marks	Comments
8(a)	$4x+9y^2\frac{\mathrm{d}y}{\mathrm{d}x}=x\frac{\mathrm{d}y}{\mathrm{d}x}+y$	M1	A correct implicit derivative
	$\frac{\mathrm{d}y}{\mathrm{d}x}(9y^2-x)=y-4x$	M1	Correct use of product rule
	$\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{y-4x}{(9y^2-x)}$	A1	Correct
	$\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{-2-4(-4)}{9\times(-2)^2--4}=\frac{14}{40}$	B1	
	Equation of tangent: $y+2=\frac{7}{20}(x+4)$	M1	Correct attempt to find *their* tangent
	$7x-20y=12$	A1	Allow $p=7$, $q=-20$, $r=12$, or any integer multiples
		6	

Q	Answer	Marks	Comments
8(b)	At *A*, $7x=12$ At *B*, $-20y=12$	M1	Both correct
	Area *OAB*, $\frac{1}{2}\times\frac{12}{7}\times\frac{12}{20}=\frac{18}{35}$	A1	
		2	

	Question 8 Total	**8**	

Q	Answer	Marks	Comments
9	$[\int e^{2x}\sin 3x\,dx]$ $u = \sin 3x \quad du = 3\cos 3x$	M1	Correct use of parts formula
	$dv = e^{2x} \qquad v = \frac{1}{2}e^{2x}$	A1	All correct
	$\int e^{2x}\sin 3x\,dx = \frac{1}{2}\sin 3x\,e^{2x} - \frac{1}{2}\int e^{2x}3\cos 3x\,dx$	A1	Correct integral
	$u = \cos 3x \quad du = -3\sin 3x$ $dv = e^{2x} \qquad v = \frac{1}{2}e^{2x}$	M1	Correct use of parts formula
	$\int e^{2x}3\cos 3x\,dx = 3\left(\frac{1}{2}\cos 3x\,e^{2x} + \frac{1}{2}\int e^{2x}3\sin 3x\,dx\right)$	A1	
	$\int e^{2x}\sin 3x\,dx =$ $\frac{1}{2}\sin 3x\,e^{2x} - \frac{3}{2}\left(\frac{1}{2}\cos 3x\,e^{2x} + \frac{1}{2}\int e^{2x}3\sin 3x\,dx\right)$	A1	Correct integral
	$\int e^{2x}\sin 3x\,dx =$ $\frac{1}{2}\sin 3x\,e^{2x} - \frac{3}{4}\cos 3x\,e^{2x} - \frac{9}{4}\int e^{2x}\sin 3x\,dx$	m1	Attempt to solve
	$\frac{13}{4}\int e^{2x}\sin 3x\,dx = \frac{1}{2}\sin 3x\,e^{2x} - \frac{3}{4}\cos 3x\,e^{2x}$ $\int e^{2x}\sin 3x\,dx = \frac{1}{13}\left[2\sin 3x\,e^{2x} - 3\cos 3x\,e^{2x}\right]$	A1	
	$\int_0^{\frac{\pi}{2}} e^{2x}\sin 3x\,dx$ $= \frac{1}{13}\left[2\sin\left(\frac{3\pi}{2}\right)e^{\pi} - 3\cos\left(\frac{3\pi}{2}\right)e^{\pi} - \left(0 - 3\cos 0\,e^{0}\right)\right]$ $= \frac{3}{13} - \frac{2}{13}e^{\pi}$	A1	

	Question 9 Total	**9**	

Q	Answer	Marks	Comments
10(a)	$\dfrac{dy}{dx}=\dfrac{\sin x(-\sin x)-\cos x\cos x}{\sin^2 x}$	M1	Use of quotient rule
	$=\dfrac{-(\sin^2 x-\cos^2 x)}{\sin^2 x}=-\dfrac{1}{\sin^2 x}=-\text{cosec}^2 x$	A1	**AG** Must be convincingly shown
		2	

Q	Answer	Marks	Comments
10(b)	$\dfrac{dy}{dx}=\dfrac{1}{\text{cosec}\,x-\cot x}\times\left(-\text{cosec}\,x\cot x+\text{cosec}^2 x\right)$	M1	Correct differentiation of ln
	$=\dfrac{-\text{cosec}\,x(\cot x-\text{cosec}\,x)}{\text{cosec}\,x-\cot x}=\text{cosec}\,x$	A1	**AG** Must be convincingly shown
		2	

Q	Answer	Marks	Comments
10(c)	$V=\pi\int_{0.5}^{1}\left(2-\text{cosec}\,2x\right)^2\,dx$	B1	Correct statement
	$\int\ =\int 4+\text{cosec}^2 2x-4\,\text{cosec}\,2x\,dx$	B1	Correct expansion
	$\int_{0.5}^{1}\ dx=[\pi]\left(4x-\frac{1}{2}\cot 2x-4\times\frac{1}{2}\ln\left(\text{cosec}\,2x-\cot 2x\right)\right)$	M1	Attempt at integration
	$=[\pi]\left(4-\frac{1}{2}\cot 2-2\ln\left(\text{cosec}\,2-\cot 2\right)\right)$	A1	All correct
	$-[\pi]\left(2-\frac{1}{2}\cot 1-2\ln\left(\text{cosec}\,1-\cot 2\right)\right)$	m1	Correct substitution of 1, 0.5 into *their* expression in the correct form
	$V=\pi(3.343-2.888)$ $=1.428$	A1	
		6	

	Question 10 Total	**10**	

Q	Answer	Marks	Comments
11(a)	$x = 3 - \sin t, \quad \sin t = 3 - x$ $y = 2 - \tan t, \quad \tan t = 2 - y$	M1	Attempt to isolate 't'
	$\operatorname{cosec} t = \dfrac{1}{3-x}, \quad \cot t = \dfrac{1}{2-y}$	A1	Attempt to eliminate 't'
	$\left(\dfrac{1}{3-x}\right)^2 = 1 + \left(\dfrac{1}{2-y}\right)^2$	A1	**ACF**
		3	

Q	Answer	Marks	Comments
11(b)	$\dfrac{dx}{dt} = -\cos t$	M1	Either correct
	$\dfrac{dy}{dt} = -\sec^2 t$ $\dfrac{dy}{dx} = \dfrac{-\sec^2 t}{-\cos t}$	A1	Both correct
	$\dfrac{dy}{dx} = \sec^3 t$	A1	
		3	

Q	Answer	Marks	Comments
11(c)	$t = \frac{\pi}{4}$ $\frac{\mathrm{d}y}{\mathrm{d}x} = \left(\sqrt{2}\right)^3$	B1	
	$x = 3 - \frac{1}{\sqrt{2}}$ $y = 1$	B1	Both correct
	$(y-1) = -\frac{1}{2\sqrt{2}}\left(x - \frac{6-\sqrt{2}}{2}\right)$	M1	
	$y = -\frac{1}{2\sqrt{2}}x + \frac{3+3\sqrt{2}}{4}$	A1	
		4	

	Question 11 Total	10	

Q	Answer	Marks	Comments
12(a)	$28x^2 - 60x + 50$ $= A(5-2x)^2 + B(5-2x)(5+4x) + C(5+4x)$	**B1**	Correctly eliminating fractions
	$x = 2.5, \quad 15C = 75, \; C = 5$	**M1**	Attempt at finding one constant
	$x = -\frac{5}{4}, \quad 675 = 225A, \quad A = 3$ $x = 0, \quad 50 = 25A + 25B + 5C, \quad B = -2$	**A1**	Two constants correct
	$\mathrm{f}(x) = \frac{3}{(5+4x)} - \frac{2}{(5-2x)} + \frac{5}{(5-2x)^2}$	**A1**	All correct
		4	

Q	Answer	Marks	Comments
12(b)(i)	$(5-2x)^{-1} = \frac{1}{5}(1-\frac{2}{5}x)^{-1}$	**M1**	
	$= \frac{1}{5} + \frac{2}{25}x + \frac{4}{125}x^2$	**A1**	
		2	

Q	Answer	Marks	Comments
12(b)(ii)	$\|x\| < 2.5$ or $-2.5 < x < 2.5$	**B1**	
		1	

Q	Answer	Marks	Comments
12(c)	$(5-2x)^{-2} = \left(\frac{1}{5}\right)^2\left(1+\frac{4}{5}x+\frac{12}{25}x^2\right)$ **oe**	**M1**	Expansion in the form $1+ax+bx^2$
	$(5-4x)^{-1} = \frac{1}{5}\left(1-\frac{4}{5}x+\frac{16}{25}x^2\right)$	**A1**	Both correct
	$f(x) = \frac{3}{5}\left(1-\frac{4}{5}x+\frac{16}{25}x^2\right)-\frac{2}{5}\left(1+\frac{2}{5}x+\frac{4}{25}x^2\right)$ $+\frac{1}{5}\left(1+\frac{4}{5}x+\frac{12}{25}x^2\right)$	**M1**	
	$f(x) = \frac{2}{5}-\frac{12}{25}x+\frac{52}{125}x^2$	**A1**	
		4	

	Question 12 Total	**11**	

Q	Answer	Marks	Comments
13(a)	$\frac{x}{x^2-x-6}=\frac{A}{x-3}+\frac{B}{x+2}$	M1	**oe PI**
	$x=3: A=\frac{3}{5}$ $x=-2: B=\frac{2}{5}$	A1	Both correct
	$\int \frac{x}{x^2-x-6}\,dx=\frac{2}{5}\int\frac{1}{(x+2)}\,dx+\frac{3}{5}\int\frac{1}{(x-3)}\,dx$		
	$=\frac{2}{5}\ln\lvert x+2\rvert+\frac{3}{5}\ln\lvert x-3\rvert$	M1 A1	Integral in correct form All correct
	$=\frac{1}{5}\ln\left(\lvert x+2\rvert^2\lvert x-3\rvert^3\right)\ [+c]$	A1	**ACF** Condone omission of modulus signs
		5	

Q	Answer	Marks	Comments
13(b)	$u = 1-2x,\ \mathrm{d}u = -2\,\mathrm{d}x \quad x = \dfrac{1-u}{2}$	M1	**oe PI**
	$x^2(1-2x)^{0.5} = \left(\dfrac{1-u}{2}\right)^2 u^{0.5}$ $= \dfrac{(1-2u+u^2)u^{0.5}}{4} \quad = \dfrac{u^{0.5}-2u^{1.5}+u^{2.5}}{4}$	A1	Both correct
	$\int x^2(1-2x)^{0.5}\mathrm{d}x = \int \dfrac{u^{0.5}-2u^{1.5}+u^{2.5}}{4} \times \dfrac{\mathrm{d}u}{-2}$	M1	Integral in correct form
	$= -\dfrac{1}{8}\left(\dfrac{u^{1.5}}{1.5} - \dfrac{2u^{2.5}}{2.5} + \dfrac{u^{3.5}}{3.5}\right)$	A1	All correct
	$[u]_1^0 = [x]_0^{0.5}$	B1	Change of limits, or change back to x
	$\int_0^{0.5} x^2(1-2x)^{0.5}\,\mathrm{d}x = -\dfrac{1}{8}\left[\dfrac{u^{1.5}}{1.5} - \dfrac{2u^{2.5}}{2.5} + \dfrac{u^{3.5}}{3.5}\right]_1^0$		
	$= -\dfrac{1}{8}\left(0 - \left(\dfrac{1}{1.5} - \dfrac{2}{2.5} + \dfrac{1}{3.5}\right)\right)$	M1	Correct subst of *their* limits into *their* expression, must be of the form $pu^{1.5} + qu^{2.5} + ru^{3.5}$
	$= \dfrac{2}{105}$	A1	
		7	

	Question 13 Total	**12**	

Q	Answer	Marks	Comments
14(a)	$\left[l_1:\ \mathbf{r} =\right]\begin{bmatrix}8\\-1\\4\end{bmatrix}+\lambda\begin{bmatrix}2\\1\\2\end{bmatrix}$	B1	oe $\left[l_1:\ \mathbf{r} =\right]\begin{bmatrix}6\\-2\\2\end{bmatrix}+\lambda\begin{bmatrix}-2\\-1\\-2\end{bmatrix}$
		1	

Q	Answer	Marks	Comments
14(b)(i)	$8+2\lambda=7+\mu$ $-1+\lambda=3+2\mu$	M1	Both equations correct **ft** From **part (a)**
	$\mu=-3$ $\lambda=-2$	A1	
	$\begin{bmatrix}4+2\lambda=0\\-3-\mu=0\end{bmatrix}$		
	Intersect at (4, –3, 0)	A1	
		3	

Q	Answer	Marks	Comments
14(b)(ii)	$\cos\theta=\dfrac{\begin{bmatrix}1\\2\\-1\end{bmatrix}\cdot\begin{bmatrix}2\\1\\2\end{bmatrix}}{\sqrt{1^2+2^2+(-1)^2}\sqrt{2^2+1^2+2^2}}$	M1	
	$=\dfrac{2}{\sqrt{6}\sqrt{9}}$	A1	
	$\theta=74.2^\circ$	A1	
		3	

Q	Answer	Marks	Comments
14(c)	$\overrightarrow{CP} = \begin{bmatrix} p-7 \\ 2p+14 \\ 3-p \end{bmatrix}$	M1	**oe** Seen or used
	$\begin{bmatrix} p-7 \\ 2p+14 \\ 3-p \end{bmatrix} \cdot \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix} [=0]$	m1	Correct use of dot product with their *CP* and their p
	$6p+18=0 \quad \Rightarrow \quad p=-3$	A1	
	Dist $= \sqrt{(-10)^2+(8)^2+(6)^2}$	M1	
	$= \sqrt{200} \quad \left[=10\sqrt{2}\right]$	A1	
		5	

	Question 14 Total	**12**	