Question		Answer	Marks	AO	Guidance
7	(a)				Note that there is an alternative method on the next page.
		$M\left(\frac{-1+2}{2}, \frac{-4+3}{2}\right)\left(=\left(\frac{1}{2}, -\frac{1}{2}\right)\right)$	**B1**	**1.1**	Correct coordinates for M – allow unsimplified. Condone missing brackets.
		$m_{AB} = \frac{3-(-4)}{2-(-1)} \quad \left(=\frac{7}{3}\right)$	**M1***	**2.1**	Attempt gradient through points A and B – 3 of the 4 values used correctly – allow unsimplified for this mark.
		$m_l = -\frac{3}{7}$	**M1***	**1.1**	$\frac{-1}{\text{their } m_{AB}}$
		$y-\left(-\frac{1}{2}\right) = -\frac{3}{7}\left(x-\frac{1}{2}\right)$	**M1dep***	**3.1a**	Attempt equation of l using **their** coordinates of M correctly and must be using negative reciprocal of **their** m_{AB}. Or $-\frac{1}{2} = -\frac{3}{7}\cdot\frac{1}{2} + c$. Must evaluate c for **M1dep*.**
		$y = -\frac{3}{7}x - \frac{2}{7}$	**A1**	**1.1**	cao oe – must be in the form $y = mx + c$.

Question			Answer	Marks	AO	Guidance
			Alternate Method			
			$r^2 = (p-2)^2 + (q-3)^2$ $r^2 = (p+1)^2 + (q+4)^2$			
				M1*		Equating their two expressions for r or r^2. Allow one sign error. May be in terms of x and y.
			$(p-2)^2 + (q-3)^2 = (p+1)^2 + (q+4)^2$	**A1**		Any correct equation.
			$p^2 - 4p + 4 + q^2 - 6p + 9$ $= p^2 + 2p + 1 + q^2 + 8q + 16$	**M1dep***		Simplifying and tidying to give three terms.
			$-4 = 6p + 14q$	**A1**		Equation in terms of p and q or x and y.
			$-4 = 6x + 14y$			
			$y = -\frac{3}{7}x - \frac{2}{7}$	**A1**		cao oe – must be in the form $y = mx + c$.
				[5]		

Question		Answer	Marks	AO	Guidance
7	(b)	$CM = \frac{\sqrt{58}}{2} \Rightarrow \left(\frac{1}{2}-p\right)^2 + \left(-\frac{1}{2}-q\right)^2 = \frac{29}{2}$	M1*	3.1a	Set up an equation with p and q using the fact that $CM = \frac{\sqrt{58}}{2}$ - if correct then $p^2 + q^2 - p + q - 14 = 0$.
		$p^2 + \left(-\frac{3}{7}p - \frac{2}{7}\right)^2 - p + \left(-\frac{3}{7}p - \frac{2}{7}\right) - 14 = 0$	M1dep*	3.1a	Using equation of l from part **(a)** to obtain an equation in either p or q only .
		$\frac{58}{49}p^2 - \frac{58}{49}p - \frac{696}{49} = 0$	M1	1.1	Simplify to a 3TQ in p or q – if correct then simplified is $p^2 - p - 12 = 0$ **- dependent on both previous M marks**. If in q: $q^2 + q - 2 = 0$. The terms do not all have to be on one side for this mark. Condone using x and y rather than p and q for these three marks.
		Alternative method for first 3 marks			
		$m_l = -\frac{3}{7} \Rightarrow k\overrightarrow{MC} = 7\mathbf{i} - 3\mathbf{j}$	M1*		Converts gradient of l correctly to a direction vector parallel to MC .
		$k\left\lvert\overrightarrow{MC}\right\rvert = \sqrt{7^2 + (-3)^2}$ $\left(\Rightarrow \sqrt{58}\right)$	M1dep*		Correct magnitude of their vector parallel to MC (allow unsimplified).
		$\overrightarrow{OC} = 0.5\mathbf{i} - 0.5\mathbf{j} + 0.5(7\mathbf{i} - 3\mathbf{j})$ $(= 4\mathbf{i} - 2\mathbf{j})$	M1		Correct use of $\overrightarrow{OC} = \overrightarrow{OM} + \overrightarrow{MC}$ using their M and their $\overrightarrow{MC} \neq$ their $7\mathbf{i} - 3\mathbf{j}$.
		$(p-4)(p+3) = 0 \Rightarrow p = 4$ and $q = -2$	A1	1.1	Both values of p and q correct. May be written as x and y values or coordinate. Allow $4\mathbf{i} - 2\mathbf{j}$.
		$r^2 = (2-4)^2 + (3-(-2))^2$	M1	1.1	Attempt to find r or r^2 using C and either A or B - if correct then $r^2 = 29$.
		$(x-4)^2 + (y+2)^2 = 29$	A1	2.1	cao
					Alternative methods are on the following pages.

Question	Answer	Marks	AO	Guidance
	Alternative Method 1			
	$\left(\frac{\sqrt{58}}{2}\right)^2 + \left(2-\frac{1}{2}\right)^2 + \left(3+\frac{1}{2}\right)^2 = r^2$ or: $\left(\frac{\sqrt{58}}{2}\right)^2 + \left(-1-\frac{1}{2}\right)^2 + \left(-4-\left(-\frac{1}{2}\right)\right)^2 = r^2$	**M1**		Attempt to find r or r^2 using Pythagoras. $CM^2 + MB^2 = r^2$ Or $CM^2 + MA^2 = r^2$
	$(p-2)^2 + (q-3)^2 = 29$ or: $(p+1)^2 + (q+4)^2 = 29$	**M1***		Set up an equation with p and q using **their** r or r^2 and A or B. Must have used **correct** methods for r or r^2.
	$(p-2)^2 + \left(-\frac{3}{7}p - \frac{2}{7} - 3\right)^2 = 29$ or: $(p+1)^2 + \left(-\frac{3}{7}p - \frac{2}{7} + 4\right)^2 = 29$	**M1dep***		Using the equation of l from part **(a)** to obtain an equation in p or q only.
	$\left(\frac{58}{49}p^2 - \frac{58}{49}p + \frac{725}{49} = 29\right)$ $\frac{58}{49}p^2 - \frac{58}{49}p + \frac{696}{49} = 0$ $(p+3)(p-4) = 0$	**M1**		Simplify to a 3 TQ in p or q. If correct then simplified is $p^2 - p - 12 = 0$ **- dependent on both previous M marks.** If in q: $q^2 + q - 2 = 0$. The terms do not all have to be on one side for this mark. Condone using x and y rather than p and q for these three marks.
	$p = 4$ and $q = -2$	**A1**		Both values of p and q correct. May be written as x and y values or coordinate.
	$(x-4)^2 + (y+2)^2 = 29$	**A1**		cao

Question	Answer	Marks	AO	Guidance
	Alternative Method 2			
	$MB^2 = \left(2-\frac{1}{2}\right)^2 + \left(3+\frac{1}{2}\right)^2 = \frac{29}{2}$			
	$\Rightarrow r^2 = \frac{29}{2} + \left(\frac{\sqrt{58}}{2}\right)^2 = 29$	**M1**		Attempt to find r or r^2 using either A or B.
	$\overrightarrow{MB} = \begin{pmatrix}1.5\\3.5\end{pmatrix}$	**M1***		oe eg $\begin{pmatrix}-1.5\\-3.5\end{pmatrix}$ soi.
	$\Rightarrow \overrightarrow{MC} = \begin{pmatrix}3.5\\-1.5\end{pmatrix}$	**A1**		(since by inspection $\lvert\overrightarrow{MB}\rvert = \lvert\overrightarrow{MC}\rvert$ and vectors are perpendicular.)
	$\Rightarrow (OC =) \begin{pmatrix}0.5\\-0.5\end{pmatrix} + \begin{pmatrix}3.5\\-1.5\end{pmatrix}$	**M1dep***		
	$(OC =) \begin{pmatrix}4\\-2\end{pmatrix}$	**A1**		Both values of p and q correct. May be written as x and y values or coordinate. Allow $4\mathbf{i} - 2\mathbf{j}$.
	$(x-4)^2 + (y+2)^2 = 29$	**A1**		
		[6]		