Question number	Scheme	Marks
9 a	$L_1 : y - 7 = m(x-4)$	B1
	Gradient of $L_2 = -\dfrac{1}{m}$	M1
	$L_2 : y - k = -\dfrac{1}{m}(x-4)$	M1
	$x = \dfrac{y-7}{m} + 4$	M1
	$y - k = -\dfrac{1}{m}\left(\dfrac{y-7}{m} + 4 - 4\right)$	M1
	$m^2 y - m^2 k = 7 - y$ $y(m^2+1) = 7 + m^2 k$	dM1
	$Y = \dfrac{7+m^2k}{m^2+1}$ *	A1 cso (7)
b	Midpoint of $AB = \left([4], \dfrac{k+7}{2}\right)$	B1
	So $\dfrac{k+7}{2} = \dfrac{7+m^2k}{m^2+1}$	M1
	$m^2k + 7m^2 + k + 7 = 2m^2k + 14$ $m^2(k-7) = k-7$	M1
	As $k \neq 7$ $m = \pm 1$ As $m < 0$ $m = -1$	A1 A1 (5)
		Total 12 marks

Part	Mark	Notes
(a)	**NOTE** ; The algebra must be correct for the first three marks.	
	B1	For writing an equation for L_1 e.g., $y-7=m(x-4)$ **OR** Uses $y=mx+c \Rightarrow y=mx+(7-4m)$
	M1	For the gradient of the perpendicular $\left(-\dfrac{1}{m}\right)$
	M1	For writing an equation for L_2 (ft a changed gradient) e.g., $y-k=-\dfrac{1}{m}(x-4)$ **OR** Uses $y=mx+c \Rightarrow y=-\dfrac{1}{m}x+\left(k+\dfrac{4}{m}\right) \Rightarrow \left[y=\dfrac{-x+km+4}{m}\right]$
	M1	For rearranging their equation of L_2 to make x the subject e.g., $x=\dfrac{y-7}{m}+4$ or $x=km-ym+4$ **ALT 1** Rearranges either equation to make $(x-4)$ the subject $x-4=\dfrac{y-7}{m}$ and/or $x-4=ym+km$ **ALT 2** Eliminates y from their equations to obtain $'x-4m+7'='\dfrac{-x+4+km}{m}' \Rightarrow x='\dfrac{4+km+4m^2-7m}{m^2+1}'$ They must reach $x=$ ……. for the award of this mark. **Allow sign errors/slips at this stage.**
	M1	Forming a linear equation in y No simplification is required at this stage. $y-k=-\dfrac{1}{m}\left(\dfrac{y-7}{m}+4-4\right)$ **ALT 1** $\dfrac{y-7}{m}=ym+km$ **ALT 2** Forms a linear equation in y using their expression for x by substituting back into either L_1 or L_2 **Allow sign errors/slips at this stage.**
	dM1	For attempting to rearrange to obtain the required result. **Allow sign errors but there must be no missing terms. You must check carefully.**
	A1	For the required result with no errors seen. $Y=\dfrac{7+m^2k}{m^2+1}$ allow $y=\dfrac{7+m^2k}{m^2+1}$

<table>
<tr><td>(b)</td><td>B1</td><td>For identifying y coordinate of the midpoint of AB
$\left([4], \frac{k+7}{2}\right)$ the x coordinate is not required for this mark.</td></tr>
<tr><td></td><td>M1</td><td>Equating the y coordinate of C and y coordinate of the midpoint to give
$\frac{k+7}{2} = \frac{7+m^2k}{m^2+1}$</td></tr>
<tr><td></td><td>M1</td><td>For rearranging and factorising to attempt achieve $m^2(k-7) = k-7$
This mark can implied by the correct value for either m^2 or m</td></tr>
<tr><td></td><td>A1</td><td>Concludes that $m = \pm 1$ $\left[m^2 = \frac{k-7}{k-7} = 1 \Rightarrow m = \pm 1\right]$
Again, this can be implied by the correct $m = -1$</td></tr>
<tr><td></td><td>A1</td><td>For $m = -1$</td></tr>
<tr><td></td><td colspan="2">ALT 1</td></tr>
<tr><td></td><td>B1</td><td>Let coordinates of C be (X, Y)

Sets: length AC = length BC
$(X-4)^2 + (Y-7)^2 = (X-4)^2 + (Y-k)^2 \Rightarrow \left[(Y-7)^2 = (Y-k)^2\right]$</td></tr>
<tr><td></td><td>M1</td><td>Using the coordinates for C of (X, Y) or otherwise, performs the following algebraic manipulation.

$(Y-7)^2 = (Y-k)^2 \Rightarrow Y^2 - 14Y + 49 = Y^2 - 2kY + k^2 \Rightarrow -14Y + 49 = -2kY + k^2$
$\Rightarrow 2Y(k-7) = (k+7)(k-7)$
$\Rightarrow 2Y = k+7$
NB: Allow sign slips, but not missing terms</td></tr>
<tr><td></td><td>M1</td><td>Substitutes in the given expression for Y and attempts to obtain $m^2(k-7) = k-7$
$\frac{7+m^2k}{m^2+1} = \frac{k+7}{2}$
$\Rightarrow 14 + 2m^2k = km^2 + 7m^2 + k + 7 \Rightarrow 7 + km^2 = 7m^2 + k$
$\Rightarrow m^2(k-7) = k-7$
NB: Allow sign slips, but not missing terms</td></tr>
<tr><td></td><td>A1</td><td>Concludes that $m = \pm 1$
$m^2 = \frac{k-7}{k-7} = 1 \Rightarrow m = \pm 1$</td></tr>
<tr><td></td><td>A1</td><td>For $m = -1$</td></tr>
<tr><td></td><td colspan="2">ALT 2</td></tr>
<tr><td></td><td colspan="2">If candidates deduces that $BAC = 45°$ and concludes that the gradient must be $m = -1$ award B1M1M1A1A1

If they leave their answer as $m = \pm 1$ or just $m = 1$, withhold the final A mark</td></tr>
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