Question Number	Scheme	Notes	Marks
3(a)	$\left\{\frac{dx}{d\alpha}=4\sinh\alpha, \frac{dy}{d\alpha}=2\cosh\alpha \Rightarrow\right\} \frac{dy}{dx}=\frac{2\cosh\alpha}{4\sinh\alpha}$ **or** $\frac{2x}{16}-\frac{2yy'}{4}=0 \Rightarrow y'=\frac{x}{4y}\left\{=\frac{4\cosh\alpha}{8\sinh\alpha}\right\}$ **or** $\left\{y=\frac{\sqrt{x^2-16}}{2}\Rightarrow\right\} y'=\frac{x}{2\sqrt{x^2-16}}\left\{=\frac{4\cosh\alpha}{2\sqrt{16\cosh^2\alpha-16}}=\frac{4\cosh\alpha}{8\sinh\alpha}\right\}$ M1: Differentiates x and y (correct forms) & divides correctly or differentiates implicitly to obtain $px-qyy'=0$ oe and reaches $y'=...$ or explicitly to obtain $y'=\frac{kx}{\sqrt{x^2-16}}$ A1: Any correct derivative **in terms of α** e.g., $\frac{1}{2}\coth\alpha$		**M1** **A1**
	$(y-2\sinh\alpha)=\frac{\cosh\alpha}{2\sinh\alpha}(x-4\cosh\alpha)$ or $2\sinh\alpha=\frac{\cosh\alpha}{2\sinh\alpha}(4\cosh\alpha)+c\Rightarrow c=...\left\{2\sinh\alpha-\frac{4\cosh^2\alpha}{2\sinh\alpha}\right\}\Rightarrow y=\frac{\cosh\alpha}{2\sinh\alpha}x+2\sinh\alpha-\frac{4\cosh^2\alpha}{2\sinh\alpha}$ Correct straight line using their **tangent** gradient **in terms of α**		**M1**
	$2y\sinh\alpha-4\sinh^2\alpha=x\cosh\alpha-4\cosh^2\alpha$ or e.g., $y\sinh\alpha+4(\cosh^2\alpha-\sinh^2\alpha)-x\cosh\alpha=0$ or e.g., $y=\frac{\cosh\alpha}{2\sinh\alpha}x-\frac{4}{2\sinh\alpha}\Rightarrow 2y\sinh\alpha-x\cosh\alpha+4=0$* Achieves the given answer (terms as printed in any order on one side) with an intermediate step. A0 if see e.g., sin for sinh.		**A1***
			(4)
(b)	$A\left(0, \frac{-2}{\sinh\alpha}\right)$ oe	M1: $y=\pm\frac{p}{\sinh\alpha}$ or $y=\pm\frac{p}{q\sinh\alpha}$ A1: $y=\frac{-2}{\sinh\alpha}$ or $y=\frac{-4}{2\sinh\alpha}$ oe For the A1 if x is given it must be 0. Could use exponentials. Allow M1A0 if just $\left(\pm\frac{p}{q\sinh\alpha},0\right)$. "sin" is 00 unless above are seen	**M1** **A1**
			(2)
(c)	**For work in terms of *a* and/or *e* score the marks once appropriate values are seen or implied. May use e.g., *F* for *S*. May see use of** $c^2=(ae)^2=a^2+b^2$		
	e.g., $b^2=a^2(e^2-1)\Rightarrow 4=a^2e^2-16$ or $4=16e^2-16\Rightarrow e^2=\frac{5}{4}\left(e=\frac{\sqrt{5}}{2}\right)\Rightarrow a^2e^2=20$ **Uses** a **correct** eccentricity formula with $a=4$ (or 16) & $b=2$ (or 4) to obtain a value for a^2e^2 or ae. Or finds a value for e and multiplies by a or a value for e^2 and $\times a^2$		**M1**
	$ae=\sqrt{20}$ or $2\sqrt{5}$ $\left\{\Rightarrow S\left(2\sqrt{5}, 0\right),\ B\left(0, 10\sinh\alpha\right)\right\}$	Correct value for ae - could be implied	**A1**
	Grad $AS=\frac{\left(\frac{2}{\sinh\alpha}\right)}{2\sqrt{5}}$ **or** Grad $BS=-\frac{10\sinh\alpha}{2\sqrt{5}}$ **or** $\overrightarrow{AS}=\begin{pmatrix}2\sqrt{5}\\ \frac{2}{\sinh\alpha}\end{pmatrix}$ **or** $\overrightarrow{BS}=\begin{pmatrix}2\sqrt{5}\\ -10\sinh\alpha\end{pmatrix}$ At least 1 correct gradient or vector (allow as "coordinates" and could be 3D). If an ambiguous fraction within fraction given, look for recovery later. Not a ft mark.		**B1**
	$\frac{\frac{2}{\sinh\alpha}}{2\sqrt{5}}\times-\frac{10\sinh\alpha}{2\sqrt{5}}$ or $\overrightarrow{AS}.\overrightarrow{BS}=\begin{pmatrix}2\sqrt{5}\\ \frac{2}{\sinh\alpha}\end{pmatrix}.\begin{pmatrix}2\sqrt{5}\\ -10\sinh\alpha\end{pmatrix}=\left(2\sqrt{5}\right)^2+\frac{2}{\sinh\alpha}\times(-10\sinh\alpha)$ (M1) $=-1$ or $=0$ so AS and BS are perpendicular/"shown" etc. (A1) M1: Writes the product of their AS and BS gradients correctly (or writes $m_1=-\frac{1}{m_2}$) or obtains a consistent scalar product expression e.g. $\overrightarrow{AS}.\overrightarrow{BS}$. Must see more than just -1 or 0. May be using exponentials/cosech. A1: Product = -1 (or $m_1=-\frac{1}{m_2}$) or scalar product = 0 with no errors and conclusion.		**M1** **A1** **(last mark requires all previous marks)**
	ALT: $AS^2+BS^2=\left(\frac{2}{\sinh\alpha}\right)^2+\left(2\sqrt{5}\right)^2+\left(10\sinh\alpha\right)^2+\left(2\sqrt{5}\right)^2$ $AB^2=\left(10\sinh\alpha+\frac{2}{\sinh\alpha}\right)^2$ (B1 - either AS^2+BS^2 (or AS^2 and BS^2) or AB^2 correct, M1 attempts both/all three, A1 **shows** equal e.g., $AB^2=\left(\frac{2}{\sinh\alpha}\right)^2+\left(10\sinh\alpha\right)^2+2\times\frac{2}{\sinh\alpha}\times10\sinh\alpha$ and conclusion)		**Alt by Pyth.**
	A0 if any sin for sinh seen. Allow work with SA and SB but A1 needs reference to AS and BS. Ignore $e=\pm\frac{\sqrt{5}}{2}$ and "S(0, 2rt5)" if recovered.		**(5)** **Total 11**