Question Number	Scheme	Marks
4(a)	$A = 93$	B1
		(1)
(b)	$100 = 125 - "93"\mathrm{e}^{-0.109T} \Rightarrow A\mathrm{e}^{-0.109T} = ...$	M1
	$A\mathrm{e}^{kT} = B \Rightarrow T = \dfrac{\ln\left(\dfrac{B}{A}\right)}{k}$	dM1
	$T = 12.05$	A1
		(3)
(c)	$\dfrac{\mathrm{d}N}{\mathrm{d}t} = 0.109 \times "93"\mathrm{e}^{-0.109\times 7}$	M1
	4 730 (total sales per month)	A1
		(2)
(d)	The limit is 125 000 / the model has a limit below 150 000	B1
		(1)
		(7 marks)

Notes

(a)

B1: 93

(b)

M1: Sets $100 = 125 - "93"\mathrm{e}^{-0.109T}$ and proceeds to $A\mathrm{e}^{-0.109T} = ...$ May use *t* instead of *T*. Condone slips.

dM1: Uses correct order of operations and correct log work from an equation of form $A\mathrm{e}^{kT} = B,\ AB > 0$ to proceed to a value for *T* (must be a solvable equation). Implied by a correct answer for their equation.

A1: 12.05 cao

Note: Candidates who use 100 000 in the equation will score no marks in this part.

Note: Answer only with no working send to review, but 12.05 following a correct equation seen score M1dM1A1.

(c)

M1: Attempts to differentiate to form $\lambda\mathrm{e}^{-0.109\times t}$, λ constant, and substitutes in $t = 7$. Award for an expression of the form $...\mathrm{e}^{-0.109\times 7}$ if no incorrect working is seen. The substitution of *t* = 7 may be implied by a correct value for their derivative of correct form.

A1: awrt 4 730 (total sales per month). Accept equivalent forms for the answer, e.g. 4.73 thousand, but just 4.73 is A0. "Sales per month" may be omitted, but score A0 if an incorrect unit is given.

Note: Answer only scores no marks.

(d)

B1: A **correct** reason given – any factual statements must be correct. E.g The limit is 125 000 / the model has a limit below 150 000 oe. Accept maximum value of *N* is 125, or *N* cannot reach 150 as asymptote at 125. Also allow attempts to substitute in 150 and find that they cannot take the log a negative number, but score B0 if a "negative time" is reached and used as reason.
Attempts using e.g 150 000 in the equation score B0.
There must be a reference to the information given in the answer, just "number is too large" or similar is B0.

Question Number	Scheme	Marks
5(a)	$\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{(x^2+k)\times\dfrac{2x}{x^2+k}-2x\ln(x^2+k)}{(x^2+k)^2}$	M1
	$\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{2x-2x\ln(x^2+k)}{(x^2+k)^2}=\dfrac{2x(1-\ln(x^2+k))}{(x^2+k)^2}$	M1A1
		(3)
(b)	$x=0$	B1
	$"1"-\ln(x^2+k)=0\Rightarrow x^2=\mathrm{e}^{"1"}\pm k$	M1
	$x=\pm\sqrt{\mathrm{e}-k}$	A1ft
		(3)
(c)	Upper limit is e or $k<\mathrm{e}$	B1ft
		(1)
		(7 marks)

Notes

(a)

M1: Attempts to apply the quotient rule. Score for an expression of the form

$\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{(x^2+k)\times\dfrac{\ldots}{x^2+k}-Qx\ln(x^2+k)}{(x^2+k)^2}$ oe (may be simplified) where … is P or Px and P,$Q>0$

May also attempt the product rule, in which case look for

$-Px(x^2+k)^{-2}\ln(x^2+k)+(x^2+k)^{-1}\times\dfrac{\ldots}{x^2+k}$ where … is Q or Qx and $P,Q>0$

M1: Cancels x^2+k and correctly takes a factor of (2)x from the numerator to achieve "$B-\ln(x^2+k)$" (may be done in one step). They must have a factor x in both terms. Note this may be scored following M0 e.g. if a numerator $uv'-vu'$ is used, or if the denominator misses the square.

A1: $\left(\dfrac{\mathrm{d}y}{\mathrm{d}x}=\right)\dfrac{2x(1-\ln(x^2+k))}{(x^2+k)^2}$ from fully correct work. Both M's must have been scored.

(b)

B1: $x=0$

M1: Sets $"1"-\ln(x^2+k)=0$ and proceeds to $x^2=\ldots$ with correct undoing of ln.

A1ft: $x=\pm\sqrt{\mathrm{e}-k}$ or follow through $x=\pm\sqrt{\mathrm{e}^B-k}$ for a numerical B in their $B-\ln(x^2+k)$ factor

(c)

B1ft: Upper limit is e or $k<\mathrm{e}$ stated. Follow on their (b) of form $x=(\pm)\sqrt{\mathrm{e}^B\pm k}$ B0 if $k=\mathrm{e}$ or $k\leqslant\mathrm{e}$ is given as the answer without statement about upper limit being e.