Question Number	Scheme	Marks
4(a)	$3x = \ln 8$ or $x = \frac{1}{3}\ln 8$ or $\log_e 8 = 3x$ or $e^x = 2$ or $e^x = \sqrt[3]{8}$ $e^x = 8^{\frac{1}{3}}$	M1
	$x = \ln 2$	A1 (2)
(b)	$2e^{3x} = \left(e^{3x} - 4\right)^2$ or $y = \left(\frac{y}{2} - 4\right)^2$	M1
	$0 = \left(e^{3x}\right)^2 - 10e^{3x} + 16$ $y^2 - 20y + 64 = 0$	A1
	$\left(e^{3x} - 8\right)\left(e^{3x} - 2\right) = 0$ $\left(y - 16\right)\left(y - 4\right) = 0$	
	$e^{3x} = 8$ $x = \frac{1}{3}\ln 8 = \ln 2$ $y = 16$	M1
	$e^{3x} = 2$ $x = \frac{1}{3}\ln 2$ $y = 4$	A1
	$(\ln 2, 16)$ $\left(\frac{1}{3}\ln 2, 4\right)$	A1 (5)
(c)	Length $PQ = \sqrt{\left(\ln 2 - \frac{1}{3}\ln 2\right)^2 + 12^2}$, $= 12.0088... = 12.009$	M1,A1 (2)
		[9]

(a)	
M1	For any one of the forms shown.
A1	Correct *exact* value for *x*. If $x = \ln 2$ is seen ignore any decimal value that follows. (NB: This is the only form of the answer that fits the demand.) Correct answer without working scores M1A1
(b)	
M1	Eliminate either variable to obtain an equation in one variable
A1	A correct 3 term quadratic, terms in any order (any equivalent of those shown) If $\left(e^{3x}\right)^2$ has been expanded incorrectly but then the mistake reversed when factorising this mark should be awarded.
M1	Factorise or use the formula for their 3TQ and solve to *x* = ... or *y* = ... Some candidates use a substitution here and sometimes it is $y = e^{3x}$ If they reverse their substitution they can achieve full marks; if they fail to reverse it the max mark available is M1A1M0A0A0
A1	2 correct *exact* values for *x* or *y* (ie 2 *x* values or 2 *y* values or correct coordinates of 1 point) Values for *x* may be any equivalent, eg $\ln\sqrt[3]{2}$
A1	Coordinates for both points correct – need not be written in coordinate brackets, but pairing must be clear. (Do not isw if incorrect pairing shown.)
(c)	
M1	Use the correct formula for the length of a line with their coordinates found in (b)
A1	Correct length of *PQ*, **must** be 3 dp