Question	Scheme	Marks	AOs
7(a)	$\frac{\mathrm{d}p}{\mathrm{d}t} \propto p \Rightarrow \frac{\mathrm{d}p}{\mathrm{d}t} = kp$	B1	3.3
	$\int \frac{1}{p}\,\mathrm{d}p = \int k\,\mathrm{d}t$	M1	1.1b
	$\ln p = kt \; \{+ c\}$	A1	1.1b
	$\ln p = kt + c \Rightarrow p = \mathrm{e}^{kt+c} = \mathrm{e}^{kt}\mathrm{e}^{c} \Rightarrow p = a\mathrm{e}^{kt}$ *	A1 *	2.1
		(4)	
(b)	$p = a\mathrm{e}^{kt} \Rightarrow \ln p = \ln a + kt$ and evidence of understanding that either • gradient $= k$ or $"M" = k$ • vertical intercept $= \ln a$ or $"C" = \ln a$	M1	2.1
	gradient $= k = 0.14$	A1	1.1b
	vertical intercept $= \ln a = 3.95 \Rightarrow a = \mathrm{e}^{3.95} = 51.935 = 52$ (2 sf)	A1	1.1b
		(3)	
(c)	e.g. • $p = a\mathrm{e}^{kt} \Rightarrow p = a(\mathrm{e}^{k})^{t} = ab^{t}$, • $p = 52\mathrm{e}^{0.14t} \Rightarrow p = 52(\mathrm{e}^{0.14})^{t}$	B1	2.2a
	$b = 1.15$ which can be implied by $p = 52(1.15)^{t}$	B1	1.1b
		(2)	
(d)(i)	Initial area (i.e. $"52"$ mm^2) of bacterial culture that was first placed onto the circular dish.	B1	3.4
(d)(ii)	E.g. • Rate of increase per hour of the area of bacterial culture • The area of bacterial culture increases by "15%" each hour	B1	3.4
		(2)	
(e)	The model predicts that the area of the bacteria culture will increase indefinitely, but the size of the circular dish will be a constraint on this area.	B1	3.5b
		(1)	
			(12 marks)

Question 7 Notes:	
(a)	
B1:	Translates the scientist's statement regarding proportionality into a differential equation, which involves a constant of proportionality. e.g. $\frac{\mathrm{d}p}{\mathrm{d}t} \propto p \Rightarrow \frac{\mathrm{d}p}{\mathrm{d}t} = kp$
M1:	Correct method of separating the variables p and t in their differential equation
A1:	$\ln p = kt$, with or without a constant of integration
A1*:	Correct proof with no errors seen in working.
(b)	
M1:	See scheme
A1:	Correctly finds $k = 0.14$
A1:	Correctly finds $a = 52$
(c)	
B1:	Uses algebra to correctly deduce either • $p = ab^t$ from $p = ae^{kt}$ • $p = "52"(e^{"0\ 14"})^t$ from $p = "52"e^{"0\ 14"t}$
B1:	See scheme
(d)(i)	
B1:	See scheme
(d)(ii)	
B1:	See scheme
(e)	
B1:	Gives a correct long-term limitation of the model for p. (See scheme).