

Question	Scheme	Marks	AOs
7(a)	$r = 10 \frac{df}{dt} - 2f \Rightarrow \frac{dr}{dt} = 10 \frac{d^2f}{dt^2} - 2 \frac{df}{dt}$	M1	2.1
	$10 \frac{d^2f}{dt^2} - 2 \frac{df}{dt} = -0.2f + 0.4 \left(10 \frac{df}{dt} - 2f \right)$	M1	2.1
	$\frac{d^2f}{dt^2} - 0.6 \frac{df}{dt} + 0.1f = 0^*$	A1*	1.1b
		(3)	
(b)	$m^2 - 0.6m + 0.1 = 0 \Rightarrow m = \frac{0.6 \pm \sqrt{0.6^2 - 4 \times 0.1}}{2}$	M1	3.4
	$m = 0.3 \pm 0.1i$	A1	1.1b
	$f = e^{\alpha t} (A \cos \beta t + B \sin \beta t)$	M1	3.4
	$f = e^{0.3t} (A \cos 0.1t + B \sin 0.1t)$	A1	1.1b
		(4)	
(c)	$\frac{df}{dt} = 0.3e^{0.3t} (A \cos 0.1t + B \sin 0.1t) + 0.1e^{0.3t} (B \cos 0.1t - A \sin 0.1t)$	M1	3.4
	$r = 10 \frac{df}{dt} - 2f$ $= e^{0.3t} ((3A + B) \cos 0.1t + (3B - A) \sin 0.1t) - 2e^{0.3t} (A \cos 0.1t + B \sin 0.1t)$	M1	3.4
	$r = e^{0.3t} ((A + B) \cos 0.1t + (B - A) \sin 0.1t)$	A1	1.1b
		(3)	
(d)(i)	$t = 0, f = 6 \Rightarrow A = 6$	M1	3.1b
	$t = 0, r = 20 \Rightarrow B = 14$	M1	3.3
	$r = e^{0.3t} (20 \cos 0.1t + 8 \sin 0.1t) = 0$	M1	3.1b
	$\tan 0.1t = -2.5$	A1	1.1b
	2019	A1	3.2a
(d)(ii)	3750 foxes	B1	3.4
(d)(iii)	e.g. the model predicts a large number of foxes are on the island when the rabbits have died out and this may not be sensible	B1	3.5a
		(7)	

(17 marks)

Question 7 notes:**(a)****M1:** Attempts to differentiate the first equation with respect to t **M1:** Proceeds to the printed answer by substituting into the second equation**A1*:** Achieves the printed answer with no errors**(b)****M1:** Uses the model to form and solve the auxiliary equation**A1:** Correct values for m **M1:** Uses the model to form the CF**A1:** Correct CF**(c)****M1:** Differentiates the expression for the number of foxes**M1:** Uses this result to find an expression for the number of rabbits**A1:** Correct equation**(d)(i)****M1:** Realises the need to use the initial conditions in the model for the number of foxes**M1:** Realises the need to use the initial conditions in the model for the number of rabbits to find both unknown constants**M1:** Obtains an expression for r in terms of t and sets $= 0$ **A1:** Rearranges and obtains a correct value for \tan **A1:** Identifies the correct year**(d)(ii)****B1:** Correct number of foxes**(d)(iii)****B1:** Makes a suitable comment on the outcome of the model