Question			Answer	Marks	AO	Guidance	
9	**(a)**		The rate at which the number of bees changes relative to the rate at which the number of flowers changes or Rate of increase of bees per increase in wildflower plants	**B1** **[1]**	**3.3**	Must mention 'rate of change' of bees, or equiv, and how this relates to wildflower plants	**B0** for 'change' not 'rate of change' **B1** for rate of change of bees with respect to plants **B1** for rate of change of bees as the plants change **B1** BOD for rate of change of bees compared to the **number** of plants State or imply that it is bees compared to flowers, so **B0** if other way around Must relate to bees and plants, and not just B and F See appendix for further examples
9	**(b)**		$\dfrac{\mathrm{d}F}{\mathrm{d}t} = 5\mathrm{e}^{0.1t}$	**B1**	**1.1**	Correct derivative No need to see $\dfrac{\mathrm{d}F}{\mathrm{d}t}$ notation	Could be unsimplified
			$\dfrac{\mathrm{d}B}{\mathrm{d}t} = 2 - 3\sin 3t$	**B1**	**1.1**	Correct derivative No need to see $\dfrac{\mathrm{d}B}{\mathrm{d}t}$ notation	NB watch out for $2 - 3\sin t$
			$\dfrac{\mathrm{d}B}{\mathrm{d}F} = \dfrac{\mathrm{d}B}{\mathrm{d}t} \times \dfrac{\mathrm{d}t}{\mathrm{d}F} = \dfrac{2 - 3\sin 3t}{5\mathrm{e}^{0.1t}}$	**M1**	**3.4**	Correct method to combine their two derivatives – algebraic or numerical	**B0B0M1** is possible Must have $\mathrm{e}^{0.1t}$ in denominator, or $\mathrm{e}^{-0.1t}$ in the numerator, but allow muddles with the placing of the 5
			$\dfrac{\mathrm{d}B}{\mathrm{d}F} = \dfrac{2 - 3\sin 12}{5\mathrm{e}^{0.4}} = 0.484$	**A1** **[4]**	**3.4**	Substitute $t = 4$ to obtain 0.484, or better	

| 9 | (b) | | **Alternative method** $t = 10\ln\left(\dfrac{F}{50}\right)$ $B = 20 + 20\ln\left(\dfrac{F}{50}\right) + \cos\left(30\ln\left(\dfrac{F}{50}\right)\right)$ $\dfrac{\mathrm{d}B}{\mathrm{d}F} = \dfrac{20}{F} - \dfrac{30}{F}\sin\left(30\ln\left(\dfrac{F}{50}\right)\right)$ $\dfrac{\mathrm{d}B}{\mathrm{d}F} = \dfrac{20}{50e^{0.4}} - \dfrac{30}{50e^{0.4}}\sin\left(30\ln\left(\dfrac{50e^{0.4}}{50}\right)\right)$ $= 0.484$ | **B1** **M1** **A1** **A1** | | Correct expression for B as a function of F Attempt differentiation Obtain correct derivative aef Substitute $F = 50e^{0.4}$ to obtain 0.484, or better | May see ln terms split first (possibly even including use of $\cos(A - B)$) Could use $t = 4$ if derivative now in terms of t |
| 9 | (c) | | The data comes from the summer, so taking it beyond 12 weeks is unlikely to be reliable | **B1** **[1]** | 3.5b | Summer will be over so pattern may not continue | Summer is not greater than 12 weeks Fewer bees and/or flowers in autumn/winter Any reason referring to a change in season having an effect on bees and/or flowers **B0** for just considering long-term behaviour eg flowers will not continue to increase exponentially Reasons must reference seasons / different time of year (could be implied by 'weather getting colder') |

APPENDIX

Exemplar responses for Q9(a)

Response	Mark	Comment
The rate of increase in the number of bees regarding the increase in the number of plants	**B1**	BOD 'regarding'
Rate of bees with respect to flowers	**B0**	no 'change'
Rate of change in number of bees in terms of the number of flowers	**B1**	BOD 'in terms of'
The rate of growth in the number of bees when the number of plants increases over time	**B1**	
The rate of change of flowers according to the number of bees	**B0**	wrong way around
The rate of increase of bees over the rate of increase in wildflowers	**B0**	not 'over' – suggests fraction
The rate of change of number of bees compared to number of plants	**B1**	BOD 'number'
Rate at which the number of bees increases as the number of plants increase	**B1**	Includes 'rate' and 'increases'
The change in number of bees in respect to the number of flowers	**B0**	no 'rate'
The rate of increase in number of bees in accordance to the number of plants	**B1**	BOD 'in accordance'
How the number of bees vary with the number of flowers	**B0**	not rate of change
The rate at which the bees to flowers ratio is changing	**B1**	BOD 'ratio'
Rate of growth of bees depending on the number of flowers	**B1**	
Rate of change of bees per wildflower plant	**B1**	
Rate of change of the number of bees in terms of flowers	**B1**	
The rate of change between the bees and the plants	**B0**	no dependency implied
The rate of change in number of bees against the change in plants	**B1**	
The rate of change of bees compared to flowers	**B1**	
Rate of change of the number of bees as the number of flowers vary	**B1**	
The rate at which the number of bees increase with the number of plants	**B1**	BOD 'with'