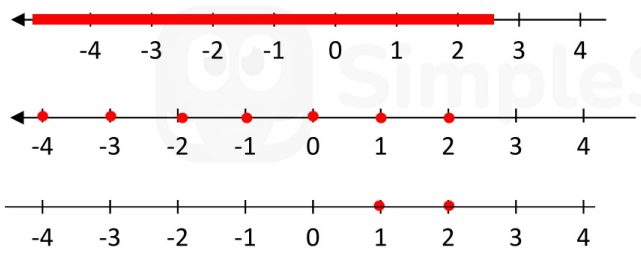
Question 1

Q3	Model Solution – 30 Marks	Marking Notes
(a)	$6x + 12 - 5 = 3$ $x = \frac{-4}{6}$ or $\frac{-2}{3}$	**Scale 15C (0, 6, 10, 15)** **Steps** 1. Distribution of 3 2. Transposing done 3. Solves *Low Partial Credit* • Work of merit for example one correct operation *High Partial Credit* • Two steps correct
(b) **(i)** **(ii)** **(iii)**		**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit* • Work of merit, for example, shows knowledge of $\mathbb{R}$, $\mathbb{Z}$, or $\mathbb{N}$. *Mid Partial Credit* • One of the three inequalities graphed correctly • Work of merit in 2 or 3 inequalities *High Partial Credit* • Two of the inequalities graphed correctly **Note**: Accept 0 in (iii) **Note:** Apply a * the first time $\geq$ is used instead of $\leq$; accept it thereafter
		

Q3	Model Solution – 30 Marks	Marking Notes
(c)	$4x - 4y = -4$ $2x + 4y = 19$ $\Rightarrow 6x = 15 \quad \Rightarrow x = \frac{15}{6} = \frac{5}{2}$ $\frac{5}{2} + 1 = y$	**Scale 10D (0, 4, 6, 8, 10)** **Four steps involved in solution.** **1.** Multiplies equation(s) so that 1 variable will cancel / express one variable in terms of the other **2.** Produce one equation in one variable **3.** Find value of one variable **4.** Find value of second variable **Note:** depending on method, step 3 may be

	$y = \frac{7}{2}$	automatically done when step 2 is completed. *Low Partial Credit* • Some work of merit, for example, relevant work in isolating one variable in one equation, or indicates multiplying one equation by a constant *Mid Partial Credit* • Two steps correct *High Partial Credit* • Three steps correct

Question 2

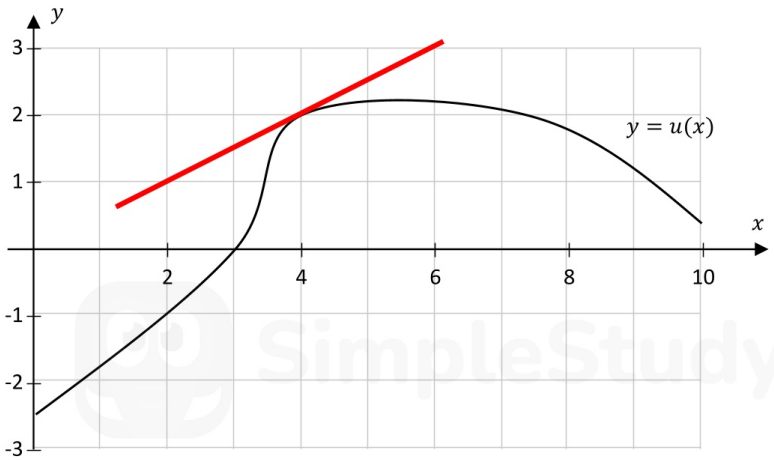
Q5	Model Solution – 30 Marks	Marking Notes
(a) (i)	$\frac{12\,000}{240} \times 320 = €16\,000$	**Scale 10B (0, 7, 10)** *Partial Credit* • Work of merit, for example 80 metres or 1/3 or 50, etc **Note:** Accept correct answer without supporting work for full credit
(a) (ii)	$6 \times 8 = 48$ $\frac{48}{4} = 12$ days	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit* • Work of merit, for example $\frac{6+8}{4}$, 6×8, divides by 4 *High Partial Credit* • Finds 48 • $\frac{6+8}{4} = \frac{14}{4}$ days (or $\frac{6+8}{4} = 3\frac{1}{2}$ days) **Note:** Accept correct answer without supporting work for full credit
(b) (i)	$\frac{120}{180}$ *or* $\frac{2}{3}$ [of an hour]	**Scale 10B (0, 7, 10)** *Partial Credit* • Time $= \frac{\text{Distance}}{\text{Speed}}$ **Note**: Full Credit -1 : 40 minutes **OR** $0 \cdot 67$ **Note:** Accept correct answer without supporting work.

Q5	Model Solution – 30 Marks	Marking Notes
(b) (ii)	$T_1 = \frac{2}{3}$ $T_2 = \frac{120}{220} = \frac{6}{11}$ $\frac{2(120)}{{}^{2}/_{3} + {}^{6}/_{11}} = 198$	**Scale 5D (0, 2, 3, 4, 5)** **4 Steps in solution:** 1. T1 2. T2 3. Sets up equation 4. Finishes correctly *Low Partial Credit* • Work of merit, for example, $\text{Time} = \frac{\text{Distance}}{\text{Speed}}$, **OR** $2(120)$ **OR** writes answer from part (i) into answer box of (ii) *Mid Partial Credit* • Two parts correct *High Partial Credit* • Three parts correct

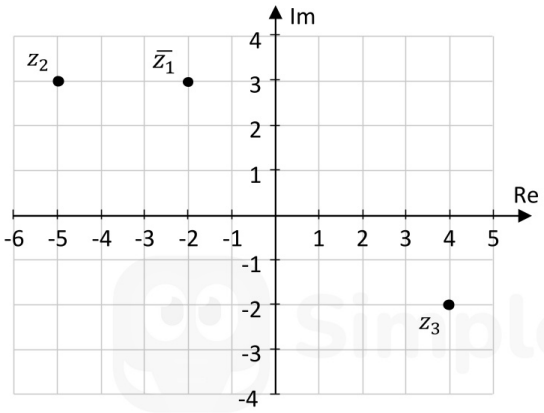
Question 3

Q4	Model Solution – 30 Marks	Marking Notes
(a) (i)	$5^3 - 7(5)^2 + 5 - 12 = -57$	**Scale 10C (0,3,7,10)** NOTE: Accept correct answer without supporting work *Low Partial Credit* • Work of merit, for example, some correct substitution *High Partial Credit* • Fully correct substitution
(a) (ii)	$g'(x) = 3x^2 - 14x + 1$	**Scale 5B (0,2,5)** *Partial Credit* • Some correct differentiation
(a) (iii)	$y - y_1 = m(x - x_1)$ $(x_1, y_1) = (5, -57)\,,\ m = 6$ $y + 57 = 6(x - 5)$ $y + 57 = 6x - 30$ $6x - y - 87 = 0$	**Scale 10C (0,3,7,10)** *Low Partial Credit* • Work of merit, for example, identifies m, or x_1, or y_1 • Equation of a line formula with some or no substitution *High Partial Credit* • Fully correct substitution NOTE: Full credit minus 1, fails to rearrange equation of the line

(b)	**(i)** *Accept any value of $x > 5$* **(ii)** Graph below [*accept any reasonable tangent that contains* $(4, 2)$] $u'(4) = \frac{2}{4}$ or $\frac{1}{2}$, approximately [*or value consistent with candidate's graph of tangent*]	**Scale 5C (0,2,3,5)** *Low Partial Credit* • 1 part correct • Indicates (4,2) on the diagram • Slope formula *High Partial Credit* • 1 part correct plus work of merit in the other

Q4	Model Solution – 30 Marks	Marking Notes
		

Question 4

Q1	Model Solution – 30 Marks	Marking Notes
(a), (b)	$z_1 = -2 - 3i$ and $\overline{z_1} = -2 + 3i$ 	**Scale 15D (0,4, 8, 12, 15)** *Low Partial Credit* • Work of merit, for example, real or imaginary part of z_1 or $\overline{z_1}$ correct, or real or imaginary part of z_2 or z_3 plotted correctly • 1 part correct *Mid Partial Credit* • 2 parts correct *High Partial Credit* • 4 parts correct NOTE: Apply F* if labels omitted

(c)	$z_2 - z_3 = -5 + 3i - (4 - 2i) = -9 + 5i$ $\lvert -9 + 5i \rvert = \sqrt{81 + 25} = \sqrt{106}$	**Scale 10D (0,3,5,8,10)** **2 parts in the solution** **1.** Finds $z_2 - z_3$ in form $a + bi$ **2.** Finds $\lvert z_2 - z_3 \rvert$ *Low Partial Credit* • Work of merit in one part, for example, some correct work in substitution for $z_2 - z_3$, or formula for Modulus *Mid Partial Credit* • One part correct • Work of merit in both parts *High Partial Credit* • One part correct and work of merit in the other part

Q1	Model Solution – 30 Marks	Marking Notes
(d)	$(4 - 2i)^2 + 2i(4 - 2i) - 7i$ $= 16 - 16i - 4 + 8i + 4 - 7i$ $= 16 - 15i \neq 0$ Therefore z_3 is not a root. NOTE: accept without "$\neq 0$" stated, as long as conclusion is correct.	**Scale 5C (0,2,3,5)** *Low Partial Credit* • Work of merit, for example, substitutes in $4 - 2i$ for z, or makes attempt to solve given equation • - b formula without substitution or partially substituted *High Partial Credit* • Fully substituted $-b$ formula • Fully substitutes in $4 - 2i$ for z, and carries out some further correct work NOTE: Apply F* if finds $16 - 15i$, but fails to make a correct conclusion

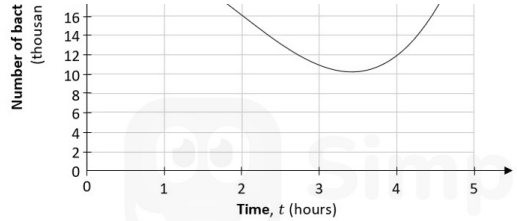
Question 5

Q6	Model Solution – 30 Marks	Marking Notes
(a) (i) & (ii)	**(i)** $y = 5 \cdot 8$ Accept y values in the range $5 \cdot 5 \leq y \leq 6$ **(ii)**	**Scale 15D (0, 5, 7, 9, 15)** *Low Partial Credit* • Work of merit, for example some correct work on diagram *Mid Partial Credit*

	$x \geq 1 \cdot 9$ Accept x values in the range $1 \cdot 7 \leq x < 2$	• **(i)** or **(ii)** correct • Work of merit in **(i) AND (ii)** *High Partial Credit* • One part correct and work of merit in the other part • Both answers correct but no work on the graph
(b) (i)	$A = \frac{1}{2}[12 + 2 \cdot 8 + 2(9 + 6 \cdot 8 + 5 \cdot 1 + 3 \cdot 8)]$ $A = 32 \cdot 1$ [units^2]	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit* • Work of merit, for example, a relevant formula or relevant addition • Relevant work on diagram *High Partial Credit* • Fully correct substitution
(b) (ii)	$\frac{32 \cdot 1 - 31 \cdot 8}{31 \cdot 8} \times 100 = 0 \cdot 943$ $= 0 \cdot 94[\%]$	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit* • Work of merit, for example, a relevant formula • Correct numerator or denominator *High Partial Credit* • Fully correct substitution • Incorrect denominator but finishes correctly *Full Credit -1* • Apply a * for no or incorrect rounding

Question 6

Q7	Model Solution – 50 Marks	Marking Notes
(a) (i) & (ii)	**(i)** **Time** | 0 | 1 | 2 | 3 | 4 | 5 **Number of bacteria** | **20** | **21** | 16 | **11** | 12 | **25** **(ii)**  	**Scale 10D (0, 3, 5, 7, 10)** **Note:** Solution requires 11 items, 4 values in table, 6 points plotted and the curve *Low Partial Credit* • 1 to 3 items correct *Mid Partial Credit* • 4 to 6 items correct *High Partial Credit* • 7 to 9 items correct

		*Full Credit -1* • Apply a * if 10 items correct
(a) (iii) & (iv)	**(iii)** $$P'(t) = 3t^2 - 12t + 6$$ **(iv)** $$P'(2) = 3(2)^2 - 12(2) + 6 = -6$$	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit* • Work of merit, for example, some correct differentiation in **(iii)** or some correct substitution in **(iv)** *Mid Partial Credit* • Work of merit in **(iii) AND (iv)** • One part correct *High Partial Credit* • One part correct and work of merit in the other part
(a) (v)	After 4 hours the number of bacteria was growing at a rate of 6000 per hour.	**Scale 10B (0, 4, 10)** *Partial Credit* • Partially correct explanation

Q7	Model Solution – 50 Marks	Marking Notes
(b) (i)	**After 1 hour:** $$3000 \times 2 \cdot 72^{0 \cdot 5(1)} = 4947 \cdot 7267$$ $$= 4948$$ **After 2 hours:** $$3000 \times 2 \cdot 72^{0 \cdot 5(2)} = 8160$$	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit* • Work of merit, for example, some correct substitution in one or both *High Partial Credit* • After 1 hour **OR** after 2 hours calculated correctly
(b) (ii)	$$3000 \times 2 \cdot 72^{0 \cdot 5(t)} > 35\,000$$ $$3000 \times 2 \cdot 72^{0 \cdot 5(4)} = 22\,195 \cdot 2$$ $$< 35\,000$$	**Scale 15C (0, 5, 8, 15)** Accept correct answer without units *Low Partial Credit* • Work of merit, for example, trialling values for n where $n \neq 1, 2$

	$3000 \times 2 \cdot 72^{0.5(5)} = 36\,605 \cdot 26$ $> 35\,000$ $n = 5$ [hours]	*High Partial Credit* • $k(4)$ and $k(5)$ calculated

Question 7

Q7	Model Solution – 50 Marks	Marking Notes
(a) (i)	$\frac{1000}{15+10} = 40$	**Scale 10B (0, 7, 10)** *Partial Credit* • Work of merit, for example substitutes in the 15 to the given formula or writes $15 + 10$ **Note:** Apply F* for $\frac{1000}{25}$ **Note:** Accept correct answer without supporting work for full credit
(a) (ii)	Answer: C decreases Reason: Because the denominator is getting bigger relative to the numerator.	**Scale 5B (0, 3, 5)** *Partial Credit* • Work of merit, for example answer correct (i.e. decreases) or indicates denominator gets bigger
(a) (iii)	$C(S+10) = 1000$ $CS + 10C = 1000$ $CS = 1000 - 10C$ $S = \frac{1000-10C}{C}$ Or $S = \frac{1000}{C} - 10$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit* • One term correct when multiplying across by $(S + 10)$ • Writes $C(S + 10)$ *High Partial Credit* • $CS = 1000 - 10C$ **Note:** $S = \frac{1000}{C+10}$ without work is zero marks

Q7	Model Solution – 50 Marks	Marking Notes
(a) (iv)	$S = \frac{1000 - 10(30)}{30} = 23 \cdot 33 \ldots$ $S = \frac{1000 - 10(100)}{30} = 0$ S goes from 0 to $23 \cdot 3$...	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit* • Carries answer from part (iii) down • Some correct substitution into $C = \frac{1000}{S + 10}$ *High Partial Credit* • Both formulas fully correctly substituted • One value correct **Note:** Award F* if both numbers are calculated correctly but no range indicated **Note:** Accept correct answers, 0 and 23 , without supporting work
(b) (i)	$P(0) = 0 \cdot 3$ $P(24) = 0 \cdot 3 + 0 \cdot 02(24) = 0 \cdot 78$	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit* • Some correct substitution *High Partial Credit* • One value correct • Both formulas fully substituted **Note:** Accept correct answers without supporting work for full credit
(b) (ii)	$P'(t) = 0 \cdot 02$ This means that the probability that it is raining in Waterville is **increasing** at a rate of 2 % every hour.	**Scale 5B (0, 3, 5)** *Partial Credit* • Work of merit in either $P'(t)$ or in explaining the meaning • Writes dy/dx
(b) (iii)	$0 \cdot 35 + 0 \cdot 02 = 0 \cdot 37$ OR $0 \cdot 3 + 0 \cdot 02t = 0 \cdot 35$ $=> t = 2 \cdot 5$ 1 hour later $t = 3 \cdot 5$ $=> 0 \cdot 3 + 0 \cdot 02(3 \cdot 5) = 0 \cdot 37$	**Scale 5B (0, 3, 5)** *Partial Credit* • Work of merit, for example indicates the probability will be higher

Question 8

(a)	€12 012 + €8472 + €49 560 = €70,044	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Any 2 of €12012 or €8472 or €49560 written or added

		High Partial Credit: • Addition of 3 terms formulated **Note**: Accept correct answer without supporting work
(b)	0·5% of 12012 = 60·06 2% of 8472 = 169·44 4·5% of 49560 = 2230·20 Total = €2459·70	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit* • Any correct formulation of any USC rate (e.g. 0·5% of 12012 or 60·06) • Any use of relevant % *Mid Partial Credit:* • Correct formulation of any 2 USC rates *High Partial Credit:* • Correct formulation of all 3 USC rates
(c)	0·5% of 12012 = 60·06 2% of 8472 = 169·44 54800 – (12012 + 8472) = 34316 4·5% of 34316 = 1544·22 Total = €1773·72	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • 60·06 or 169·44 transferred from above • 34316 found • Any use of relevant % • 20 484 found *Mid Partial Credit:* • 4·5% of 34316 *High Partial Credit:* • Correct formulation of all 3 USC rates
(d)	1602·72 − [60·06 + 169·44] = 1373·22 $\frac{1373·22}{4·5} \times 100 = 30516$ 30516 + 12012 + 8472 = €51,000	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • 60·06 or 169·44 transferred from above • Any use of relevant % *Mid Partial Credit:* • 1373·22 *High Partial Credit:* • 30 516
(e)	Top rate USC = 3496·18 − (2459·70) = 1036·48 83000 − 70044 = 12956 $\frac{1036·48}{12956} \times 100 = 8\%$	**Scale 15D (0, 4, 7, 11, 15)** *Low Partial Credit:* • 2459·70 transferred from above • 70 044 transferred from above • Relevant figures transferred from section (a) and / or (b) • Correct answer without supporting work *Mid Partial Credit:* • (3496·18 − 2459·70) or 1036·48 • (83000 − 70044) or 12956

High Partial Credit:

- 1036·48 and 12956