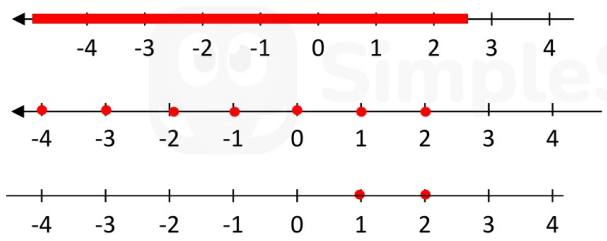
Question 1

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 automatically done when step 2 is

		$y = \frac{}{2}$	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

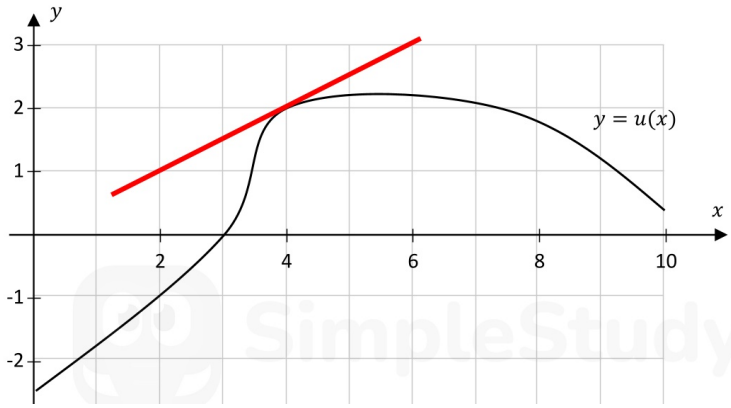
Question 2

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, 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

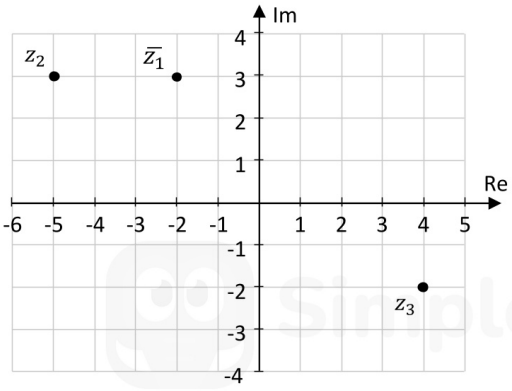
Question 3

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
		


-3

Question 4

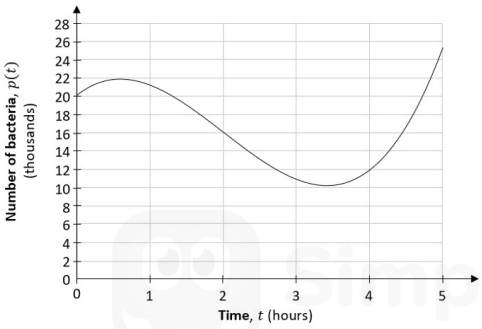
Q1	Model Solution – 30 Marks	Marking Notes
(a), (b)	$z_1 = -2 - 3i$ and $\overline{z_1} = -2 + 3i$  	**Scale 15D (0,4, 8, 12, 15)** *Low Partial Credit* • Work of merit, for example, real or imaginary part of z_1 or $\overline{z_1}$ correct, or real or imaginary part of z_2 or z_3 plotted correctly • 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)** $x \geq 1 \cdot 9$ Accept x values in the range $1 \cdot 7 \leq x < 2$	**Scale 15D (0, 5, 7, 9, 15)** *Low Partial Credit* • Work of merit, for example some correct work on diagram *Mid Partial Credit* • **(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

<table>
<tr><th>Q7</th><th>Model Solution – 50 Marks</th><th>Marking Notes</th></tr>
<tr><td>(a)
(i)
&
(ii)</td><td>(i)
<table><tr><td>Time</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Number of bacteria</td><td>20</td><td>21</td><td>16</td><td>11</td><td>12</td><td>25</td></tr></table>
(ii)
 
</td><td>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</td></tr>
<tr><td>(a)
(iii)
&
(iv)</td><td>(iii)
$$P'(t) = 3t^2 - 12t + 6$$
(iv)
$$P'(2) = 3(2)^2 - 12(2) + 6 = -6$$</td><td>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</td></tr>
<tr><td>(a)
(v)</td><td>After 4 hours the number of bacteria was growing at a rate of 6000 per hour.</td><td>Scale 10B (0, 4, 10)

Partial Credit
• Partially correct explanation</td></tr>
</table>

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)	$3000 \times 2 \cdot 72^{0 \cdot 5(t)} > 35\,000$ $3000 \times 2 \cdot 72^{0 \cdot 5(4)} = 22\,195 \cdot 2$ $< 35\,000$ $3000 \times 2 \cdot 72^{0 \cdot 5(5)} = 36\,605 \cdot 26$ $> 35\,000$ $n = 5$ [hours]	**Scale 15C (0, 5, 8, 15)** Accept correct answer without units *Low Partial Credit* • Work of merit, for example, trialling values for n where $n \neq 1, 2$ *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)	$$S=\frac{1000-10(30)}{30}=23\cdot33\ldots$$ $$S=\frac{1000-10(100)}{30}=0$$ S goes from 0 to $23\cdot3$...	**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 $0 \cdot 3 + 0 \cdot 02t = 0 \cdot 35$ $=> t = 2 \cdot 5$ $1 \text{ hour later } t = 3 \cdot 5$ $=> 0 \cdot 3 + 0 \cdot 02(3 \cdot 5) = 0 \cdot 37$	**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)

$1602{\cdot}72 - [60{\cdot}06 + 169{\cdot}44] =$

$1373{\cdot}22$

$\frac{1373{\cdot}22}{4{\cdot}5} \times 100 = 30516$

$30516 + 12012 + 8472$

$= €51{,}000$

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

Scale 15D (0, 4, 7, 11, 15)

Low Partial Credit:

- 2459·70 transferred from above
- 70 044 transferred from above

		$83000 - 70044 = 12956$ $\frac{1036{\cdot}48}{12956} \times 100 = 8\%$	• Relevant figures transferred from section (a) and / or (b) • Correct answer without supporting work *Mid Partial Credit:* • $(3496{\cdot}18 - 2459{\cdot}70)$ or $1036{\cdot}48$ • $(83000 - 70044)$ or 12956 *High Partial Credit:* • $1036{\cdot}48$ and 12956