Question 1

(a) $y = \dfrac{5}{8}x + \dfrac{7}{2}$ $(y = 0.625x + 3.5)$ **A1A1**

> **Note:**   Award **A1** for 0.625x, **A1** for 3.5.
> Award a maximum of **A0A1** if not part of an equation.

[2 marks]

(b)   (i) $y = -0.975x^2 + 9.56x - 16.7$ **(M1)A1**

$(y = -0.974630x^2 + 9.55919x - 16.6569...)$

(ii)   gradient of curve is positive at $x = 4$ **R1**

> **Note:**   Accept a sensible rationale that refers to the gradient.

[3 marks]

(c)   **METHOD 1**

let $y = ax^2 + bx + c$

differentiating or using $x = \dfrac{-b}{2a}$ **(M1)**

$8a + b = 0$

substituting in the coordinates
$7.5^2 a + 7.5b + c = 0$ **(A1)**
$4^2 a + 4b + c = 6$ **(A1)**

solve to get

$y = -\dfrac{24}{49}x^2 + \dfrac{192}{49}x - \dfrac{90}{49}$ **OR** $y = -0.490x^2 + 3.92x - 1.84$ **A1**

> **Note:**   Use of quadratic regression with points using the symmetry
> of the graph is a valid method.

METHOD 2

$y = a(x - 4)^2 + 6$ **(M1)**
$0 = a(7.5 - 4)^2 + 6$ **(M1)**

$a = -\dfrac{24}{49}$ **(A1)**

$y = -\dfrac{24}{49}(x - 4)^2 + 6$ **OR** $y = -0.490(x - 4)^2 + 6$ **A1**

[4 marks]

(d) (i) $\pi\int_0^4\left(\frac{5}{8}x+3.5\right)^2 dx + \pi\int_4^{7.5}\left(-\frac{24}{49}(x-4)^2+6\right)^2 dx$ (M1)(M1)(M1)A1

> **Note:** Award **(M1)(M1)(M1)A0** if π is omitted but response is otherwise correct. Award **(M1)** for an integral that indicates volume, **(M1)** for their part (a) within their volume integral, **(M1)** for their part (b)(i) within their volume integral, **A1** for their correct two integrals with all correct limits.

(ii) 501 cm^3 (501.189...)   **A1**

[5 marks]

Total [14 marks]

Question 2

(a) (i) 1200   **A1**

(ii) the initial population of the bacteria   **A1**

[2 marks]

(b) $1200\times k^3 = 18750$ **(A1)**

$(k=)$ 2.5   **A1**

[2 marks]

(c) $1200\times 2.5^{1.5}$ **(A1)**

4740 (4743.41…)   **A1**

> **Note:** Do not penalize if final answer is not given as an integer. Award **(A1)A0** for an answer of 3950 (3949.14…) from use of 1.3 in the exponent, but only if working is shown.

[2 marks]

(d) equating $P(t)$ and $S(t)$ **OR** equating each function to a common variable   **(M1)**

$1200\times 2.5^t = 5000\times 1.65^t$; $1200\times 2.5^t = x$ and $5000\times 1.65^t = x$

$t = 3.43$ (hours) (3.43456...)   **A1**

[2 marks]

(e) **METHOD 1**

$5000 \times 1.65^t = 19000$ (M1)

$(t =) \ 2.66586...$ **OR** $(t-2=) \ 0.66586...$ (seen) (A1)

multiplying by 60 seen to convert to minutes (M1)
$(m = 39.9521...)$

$(m =) \ 40$ (minutes) **OR** 2 hours and 40 minutes **A1**

METHOD 2

equating an expression for $S(t)$ to 19000 (M1)

expressing t as $2 + \dfrac{m}{60}$ (A1)

$5000 \times 1.65^{2 + \frac{m}{60}} = 19000$

$2 + \dfrac{m}{60} = 2.66586...$ **A1**

$(m =) \ 40$ (minutes) **OR** 2 hours and 40 minutes **A1**

Note: Award *(M1)(A1)(M1)A0* for an answer of $39.9521...$ or 39 with or without working.

[4 marks]
Total [12 marks]