Question 1

(a)   (i)   1750   *A1*

(ii) $1350 + 400\,(1.25)^{-5}$ *(M1)*

$= 1480$ *A1*

Note: Accept 1481.
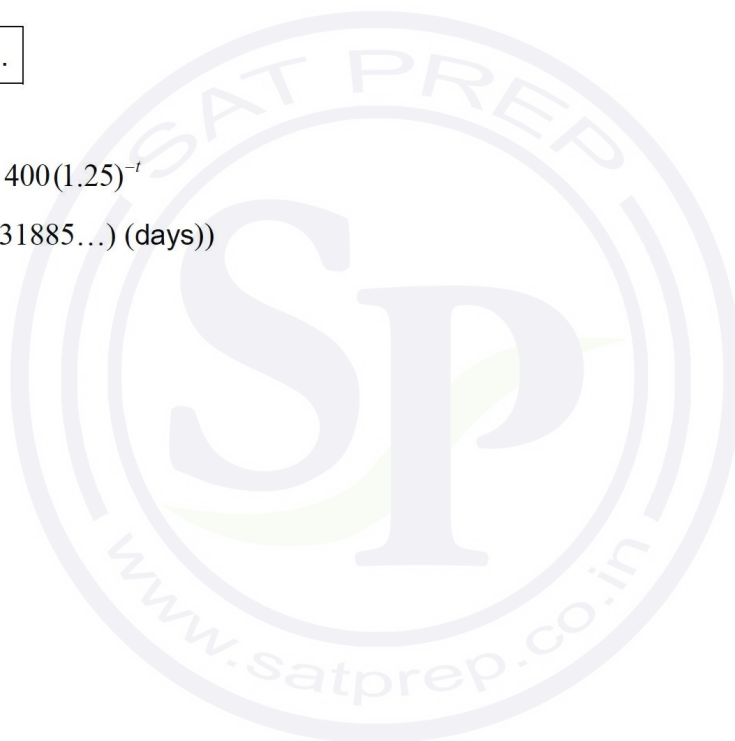
[3 marks]

(b) $1400 = 1350 + 400(1.25)^{-t}$ *(M1)*

9.32 (days (9.31885…) (days))   *A1*
                                                                                                        [2 marks]

(c)   1350   *A1*
                                                                                                        [1 mark]

Total [6 marks]

Question 2

(a)   20   *A1*
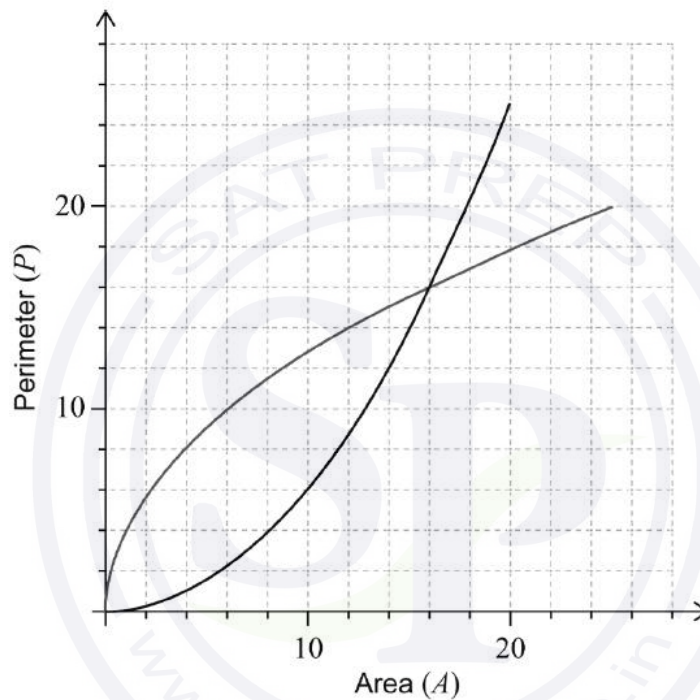   *[1 mark]*

(b) $n = 20$ *A1*

> **Note:** Follow through from part (a).

                                                                                                          [1 mark]

(c)

                                                                                                      (M1)A1A1

> **Note:** Award *(M1)* for reflection in the line $P = A$, award *A1* for
> endpoint at $(20, 25)$, award *A1* for passing through $(16, 16)$.

                                                                                                          [3 marks]

(d)   when the perimeter is 8, the area is 4   *A1*
                                                                                                          [1 mark]

                                                                                              Total [6 marks]

Question 3

(a)   3   *A1*

> **Note:** Accept $(3, 0)$ seen.

[1 mark]

(b)   **METHOD 1**

$$0 = 4a - 2b + c \,, \quad 0 = 9a + 3b + c \,, \quad -\frac{25}{2} = \frac{1}{4}a + \frac{1}{2}b + c$$ *(M1)(A1)*

   (i)   2   *A1*

   (ii) -2 *A1*

   (iii) -12 *A1*

> **Note:** Award the *(M1)(A1)* if at least one correct value is seen.
> Do not apply *FT* form part (a) if workings are not shown.

METHOD 2

$$-12.5 = a(0.5 + 2)(0.5 - 3)$$ *(M1)*

   (i) $a = 2$ *A1*

$$0 = 2 \times (3)^2 + 3b + c$$
$$0 = 2 \times (-2)^2 + (-2)b + c$$ *(M1)*

   (ii) $b = -2$ *A1*

   (iii) $c = -12$ *A1*

[5 marks]

(c) $x = 0.5$ *A1*

> **Note:** Do not *FT* from their part (b), this is a contradiction with the diagram.

[1 mark]

Total [7 marks]

Question 4

(a) $\left(f(-7)=\right)\ 8$ and $\left(f(7)=\right)\ 1$ **(A1)**

range is $f(x)\le 1,\ f(x)\ge 8$ **A1A1**

> **Note:** Award at most **A1A1A0** if strict inequalities are used.

[3 marks]

(b) **EITHER**

sketch of f and $y=0$ or sketch of f^{-1} and $x=0$ **(M1)**

OR

finding the correct expression of $f^{-1}(x)=\dfrac{-2-5x}{x-2}$ **(M1)**

OR

$f^{-1}(0)=\dfrac{-2-5(0)}{0-2}$ **(M1)**

OR

$f(x)=0$ **(M1)**

THEN

$f^{-1}(0)=1$ **A1**

[2 marks]

Total [5 marks]

Question 5

(a) (i)   23 mg   **A1**

(ii) $1-0.85$ **OR** $\dfrac{23-19.55}{23}$ **OR** 0.15 **(M1)**

15 (%)   **A1**

[3 marks]

(b) $23(0.85)^{10}$ **(M1)**

4.53 mg (4.52811…)   **A1**

[2 marks]

Total [5 marks]

Question 6

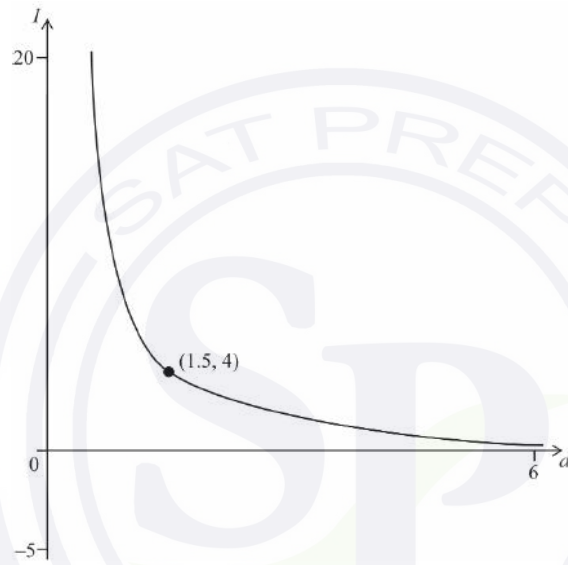(a) $I = \dfrac{k}{d^2}$ (M1)

   $4 = \dfrac{k}{1.5^2}$ **M1**

   $I = \dfrac{9}{d^2}$ **AG**

   [2 marks]

(b)

   A1A1

   [2 marks]

(c) $1.5 \times 10^{-6} \geq \dfrac{9}{d^2}$ (M1)

   Note: Award **(M1)** for a correct inequality.

   $d \geq 2450$ (m) $(2449.48\ldots)$ **A1**

   Note: Award **A0** for $d = 2450$.

   [2 marks]

   Total [6 marks]

Question 7

(a) **EITHER**

$50 = 100\,e^{-1\times p}$ **OR** $0.5 = e^{-1\times p}$ **(M1)**

OR

                                                                         (M1)

THEN

0.693 $(0.693147..., \ln 2)$ **A1**

[2 marks]

(b) $R(1.5) = 100\,e^{-0.693147...\times1.5}$ **(M1)**

$35.4\,(\%)$ $(35.3553...)$ **A1**

[2 marks]

(c) $R(t) > 0$ **OR** $R(t)$ has a horizontal asymptote   **R1**

[1 mark]

(d)   *Award **A1** for **one** reasonable limitation of the domain:*   **A1**
       small values of t produce unrealistic results
       $R(0) = 100\%$
       large values of t are not possible
       people do not live forever
       model is not valid at small or large values of t

   The reason should focus on the domain $t \geq 0$. Do not accept answers such as:
       recollection varies for different people
       memories are discrete not continuous
       the nature of the information will change how easily it is recalled
       emotional/physical stress can affect recollection/concentration

Note: Do not accept $t \geq 0$ as this is a limitation that has been given in the question.

[1 mark]

Total [6 marks]

Question 8

(a) $L(40) = 1.50 \times 40 - 5$ **(M1)**

            $= \$\,55$ **A1**

                                                            [2 marks]

(b) $70 = 1.50x - 5$ **(M1)**

            $(x =)\ 50$ litres   **A1**

                                                            [2 marks]

(c) $1.30x$ **(A1)**
        $1.30x < 1.50x - 5$ **(M1)**

> **Note:** Award **M1** for a graph showing two intersecting linear functions, provided one function has a y-intercept of 0 and the other function has a negative y-intercept.

       (minimum value of $k =$) 25   **A1**

> **Note:** Accept $x > 25$.

                                                           [3 marks]

                                                   Total [7 marks]

Question 9

(a) $h(4) = \dfrac{640}{4^2} + 0.5$ **OR** $h(14) = \dfrac{640}{14^2} + 0.5$ **(M1)**

> **Note:** Award **(M1)** for substituting 4 or 14 into h. This can be implicit from seeing 3.77 (3.76530…) or 40.5.

        $3.77 \le h(x) \le 40.5$ $(3.76530... \le h(x) \le 40.5)$ **A1A1**

> **Note:** Award **A1** for both correct endpoints seen, **A1** for the endpoints in a correct interval.

                                                         [3 marks]

(b) (i) $h(x) = 10$ **OR** $h^{-1}(x) = \sqrt{\dfrac{640}{x - 0.5}}$ **OR** $h^{-1}(10) = \sqrt{\dfrac{640}{10 - 0.5}}$ **(M1)**

            $(x =)\ 8.21$ cm $(8.20782...)$ **A1**

    (ii)   a tin that is 10 cm high will have a diameter of 8.21 cm (8.20782...)   **A1**

> **Note:** Condone a correct answer expressed as the converse.

    (iii) $4 \le h^{-1} \le 14$ **A1**

> **Note:** Accept $4 \le y \le 14$. Do not **FT** in this part.

                                                          [4 marks]
                                                   Total: [7 marks]

Question 10

(a) $(A =)$ 112   **A1**

[1 mark]

(b) $112\,e^{5k} = 360$ **(M1)**

> **Note:** Award **(M1)** for their correct equation.

EITHER

graph of $y = 112\,e^{5x}$ and $y = 360$ with indication of point of intersection   **(M1)**

OR

$(k =)\ \dfrac{1}{5}\ln\left(\dfrac{360}{112}\right)$ **(M1)**

> **Note:** Award **(M1)** for correct rearranging and use of log.

THEN

$(k =)\ 0.234\ (0.233521...)$ **A1**

> **Note:** Award **(M1)(M1)(A0)** for 0.233.

[3 marks]
Total: [4 marks]

Question 11

(a)   1.2 metres   **A1**

[1 mark]

(b) $-4.8t^2 + 21t + 1.2 = 0$ **(M1)**
        $(t =)\ 4.43\ \text{s}\ (4.431415...\ \text{s})$ **A1**

> **Note:** If both values for t are seen do not award the **A1** mark unless the negative is explicitly excluded.

[2 marks]

(c) $0 \le t \le 4.43$ **OR** $[0, 4.43]$ **A1A1**

> **Note:** Award **A1** for correct endpoints and **A1** for expressing answer with correct notation. Award at most **A1A0** for use of x instead of t.

[2 marks]
[Total 5 marks]

Question 12

(a) $(x =) -\dfrac{4.48}{2(-1.6)}$ **OR** coordinates of maximum point $(1.4, 3.136)$ **(M1)**

$x = 1.4$ **A1**

[2 marks]

(b) **METHOD 1**
the cart is centred in the archway when it is between
$x = 0.6$ and $x = 2.2$, **A1**
where $y \geq 2.112$ (m) (which is greater than 2) **R1**

the archway is tall enough for the crate **A1**

Note: Do not award **R0A1**.

METHOD 2
the height of the archway is greater or equal to 2.0 between
$x = 0.557385\ldots$ and $x = 2.24261\ldots$ **A1**
width of this section of archway =
$(2.24261\ldots - 0.557385\ldots =)$ $1.68522\ldots$ (m) (which is greater than 1.6) **R1**

the archway is wide enough for the crate **A1**

Note: Do not award **R0A1**.

[3 marks]
Total [5 marks]

Question 13

(a) $71e^{-0.0514(16)} + 23$ **(M1)**

$54.2\ °C$ $(54.1956\ldots)$ **A1**

[2 marks]

(b) $T = 23$ **A1**

Note: Condone $y = 23$.

[1 mark]

(c) $23\ °C$ **A1**

[1 mark]

(d) $50 = 71e^{-0.0514(k)} + 23$ **(M1)**

$k = 18.8$ $\left(\dfrac{-5000}{257}\ln\left(\dfrac{27}{71}\right),\ 18.8101\ldots\right)$ **A1**

[2 marks]
Total [6 marks]

Question 14

(a)   1.8 (m)   *A1*

[1 mark]

(b)   **EITHER**

$$\frac{-10.8}{2(-3.6)}$$ *(M1)*

OR

$-7.2(t) + 10.8 = 0$ *(M1)*

OR

sketch indicating maximum   *(M1)*

THEN

$(t =)$ 1.5 seconds   *A1*

[2 marks]

(c)   **EITHER**

$0 = -3.6t^2 + 10.8t + 1.8$ *(M1)*

OR

sketch indicating a root   *(M1)*

THEN

$(t =)$ 3.16 seconds (3.15831...)   *A1*

[2 marks]
Total [5 marks]