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**4.** The growth of a weed on the surface of a pond is being studied.

The surface area of the pond covered by the weed, $A\,\text{m}^2$, is modelled by the equation

$$A = \frac{80pe^{0.15t}}{pe^{0.15t} + 4}$$

where $p$ is a positive constant and $t$ is the number of days after the start of the study.

Given that

- $30\,\text{m}^2$ of the surface of the pond was covered by the weed at the start of the study
- $50\,\text{m}^2$ of the surface of the pond was covered by the weed $T$ days after the start of the study

(a) show that $p = 2.4$

**(2)**

(b) find the value of $T$, giving your answer to one decimal place.

(*Solutions relying entirely on graphical or numerical methods are not acceptable.*)

**(4)**

The weed grows until it covers the surface of the pond.

(c) Find, according to the model, the maximum possible surface area of the pond.

**(1)**

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**Question 4 continued**

**Q4**

**(Total 7 marks)**

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**5.**

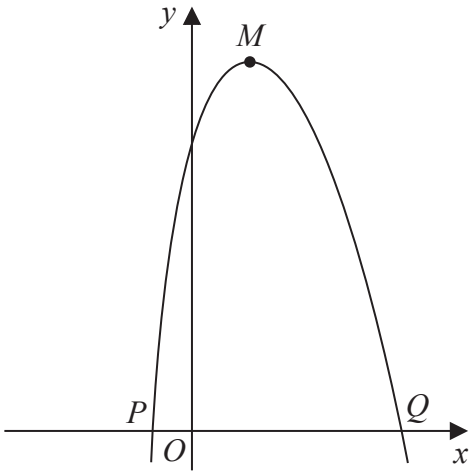



**Figure 1**

Figure 1 shows a sketch of part of the curve with equation

$$y = 6\ln(2x + 3) - \frac{1}{2}x^2 + 4 \qquad x > -\frac{3}{2}$$

The curve cuts the negative $x$-axis at the point $P$, as shown in Figure 1.

(a) Show that the $x$ coordinate of $P$ lies in the interval $[-1.25, -1.2]$

**(2)**

The curve cuts the positive $x$-axis at the point $Q$, also shown in Figure 1.

Using the iterative formula

$$x_{n+1} = \sqrt{12\ln(2x_n + 3) + 8} \quad \text{with} \quad x_1 = 6$$

(b) (i) find, to 4 decimal places, the value of $x_2$

(ii) find, by continued iteration, the $x$ coordinate of $Q$. Give your answer to 4 decimal places.

**(3)**

The curve has a maximum turning point at $M$, as shown in Figure 1.

(c) Using calculus and showing each stage of your working, find the $x$ coordinate of $M$.

**(4)**

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