



The diagram shows the part of the curve $y = 3x \sin 2x$ for which $0 \leq x \leq \frac{1}{2}\pi$.

The maximum point on the curve is denoted by P .

- (a) Show that the x -coordinate of P satisfies the equation $\tan 2x + 2x = 0$. [3]
- (b) Use the Newton-Raphson method, with a suitable initial value, to find the x -coordinate of P , giving your answer correct to 4 decimal places. Show the result of each iteration. [4]

- (c) The trapezium rule, with four strips of equal width, is used to find an approximation to

$$\int_0^{\frac{1}{2}\pi} 3x \sin 2x \, dx.$$

Show that the result can be expressed as $k\pi^2(\sqrt{2} + 1)$, where k is a rational number to be determined. [4]

- (d) (i) Evaluate $\int_0^{\frac{1}{2}\pi} 3x \sin 2x \, dx$. [1]
- (ii) Hence determine whether using the trapezium rule with four strips of equal width gives an under- or over-estimate for the area of the region enclosed by the curve $y = 3x \sin 2x$ and the x -axis for $0 \leq x \leq \frac{1}{2}\pi$. [1]
- (iii) Explain briefly why it is not easy to tell from the diagram alone whether the trapezium rule with four strips of equal width gives an under- or over-estimate for the area of the region in this case. [1]