9. $h(x) = 8 + 3\sin x(\cos x - 2\sin x) \quad 0 \leqslant x \leqslant 2\pi$

(a) Write $h(x)$ in the form

$$P + R\sin(2x + \alpha)$$

where P, R and α are positive constants, $0 < \alpha < \frac{\pi}{2}$

Give the exact values of P and R and give the value of α, in radians, to 3 decimal places.

(6)

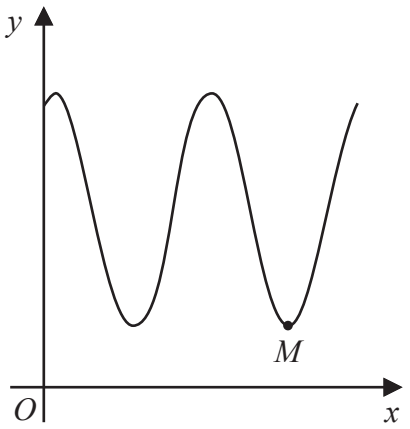


Figure 2

Figure 2 is a sketch of the curve with equation $y = h(x)$

(b) State the range of h.

(1)

The point M, shown in Figure 2, is the minimum point on the curve with the largest x coordinate.

(c) Find the x coordinate of M.

(Solutions based entirely on calculator technology are not acceptable.)

(2)

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Question 9 continued

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Question 9 continued

(Total for Question 9 is 9 marks)

10. **In this question you must show all stages of your working.**
Solutions relying entirely on calculator technology are not acceptable.

Two populations of insects are being studied over the same period of time.

The number of insects N_A in population A, t years after the start of the study, is modelled by the equation

$$N_A = 8000 + 900e^{0.2t}$$

According to the model,

(a) find the rate of growth in the number of insects in population A exactly 5 years after the start of the study.

(2)

The number of insects N_B in population B, t years after the start of the study, is modelled by the equation

$$N_B = 8000 + Pe^{kt}$$

where P and k are positive constants.

Given that

- there are 10 000 insects in population B at the start of the study
- there are 11 570 insects in population B exactly 4 years after the start of the study
- there are the same number of insects in population A and population B after T years

find, according to the models,

(b) the exact value of P and the value of k to 3 decimal places,

(4)

(c) the value of T, giving your answer to one decimal place.

(3)

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