

## STEP II, 2009, Q2

- 2 The curve  $C$  has equation

$$y = a^{\sin(\pi e^x)},$$

where  $a > 1$ .

- (i) Find the coordinates of the stationary points on  $C$ .
- (ii) Use the approximations  $e^t \approx 1 + t$  and  $\sin t \approx t$  (both valid for small values of  $t$ ) to show that

$$y \approx 1 - \pi x \ln a$$

for small values of  $x$ .

- (iii) Sketch  $C$ .
- (iv) By approximating  $C$  by means of straight lines joining consecutive stationary points, show that the area between  $C$  and the  $x$ -axis between the  $k$ th and  $(k + 1)$ th maxima is approximately

$$\left(\frac{a^2 + 1}{2a}\right) \ln \left(1 + \left(k - \frac{3}{4}\right)^{-1}\right).$$



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