

QQQ – Further Pure 1 – Chapter 7 – Methods in Calculus (Version 2)

Total Marks: 24

(24 = Platinum, 22 = Gold, 19 = Silver, 16 = Bronze)

1. Given that k is a real non-zero constant and that

$$y = x^3 \sin kx$$

use Leibnitz's theorem to show that

$$\frac{d^5 y}{dx^5} = (k^2 x^2 + A)k^3 x \cos kx + B(k^2 x^2 + C)k^2 \sin kx$$

where A , B and C are integers to be determined.

(4)

(Total 4 marks)

Edexcel A2 June 2019 Q2

2. Use l'Hospital's Rule to show that

$$\lim_{x \rightarrow \frac{\pi}{2}} \frac{(e^{\sin x} - \cos(3x) - e)}{\tan(2x)} = -\frac{3}{2}$$

(5)

(Total 5 marks)

Edexcel A2 October 2020 Q1

3.

In this question you must show all stages of your working.

Solutions relying on calculator technology are not acceptable.

- (a) Use the substitution $t = \tan\left(\frac{\theta}{2}\right)$ to show that

$$\int \frac{1}{2 \sin \theta + \cos \theta + 2} d\theta = \int \frac{a}{(t + b)^2 + c} dt$$

where a , b and c are constants to be determined. **(3)**

- (b) Hence show that

$$\int_{\frac{\pi}{2}}^{\frac{2\pi}{3}} \frac{1}{2 \sin \theta + \cos \theta + 2} d\theta = \ln\left(\frac{2\sqrt{3}}{3}\right)$$

(4)

(Total 7 marks)

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4.

$$f(x) = x^4 \sin(2x)$$

Use Leibnitz's theorem to show that the coefficient of $(x - \pi)^8$ in the Taylor series expansion of $f(x)$ about π is

$$\frac{a\pi + b\pi^3}{315}$$

where a and b are integers to be determined.

(8)

$$\left[\begin{array}{l} \text{The Taylor series expansion of } f(x) \text{ about } x = k \text{ is given by} \\ f(x) = f(k) + (x - k)f'(k) + \frac{(x - k)^2}{2!}f''(k) + \dots + \frac{(x - k)^r}{r!}f^{(r)}(k) + \dots \end{array} \right]$$

(Total 8 marks)

Edexcel A2 October 2020 Q4