

GCE Examinations  
Advanced Subsidiary

## Core Mathematics C4

Paper C

### MARKING GUIDE

This guide is intended to be as helpful as possible to teachers by providing concise solutions and indicating how marks could be awarded. There are obviously alternative methods that would also gain full marks.

Method marks (M) are awarded for knowing and using a method.

Accuracy marks (A) can only be awarded when a correct method has been used.

(B) marks are independent of method marks.



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## C4 Paper C – Marking Guide

1.  $u = \ln x, u' = \frac{1}{x}, v' = x, v = \frac{1}{2}x^2$  M1  
 $I = \left[ \frac{1}{2}x^2 \ln x \right]_1^2 - \int_1^2 \frac{1}{2}x \, dx$  A1  
 $= \left[ \frac{1}{2}x^2 \ln x - \frac{1}{4}x^2 \right]_1^2$  M1 A1  
 $= (2 \ln 2 - 1) - (0 - \frac{1}{4}) = 2 \ln 2 - \frac{3}{4}$  M1 A1 (6)
- 
2. 

	$x$	0	0.5	1	1.5	2	
	$\arctan x$	0	0.4636	0.7854	0.9828	1.1071	B2

  
(a)  $\approx \frac{1}{2} \times 1 \times [0 + 1.1071 + 2(0.7854)] = 1.34$  (3sf) B1 M1 A1  
(b)  $\approx \frac{1}{2} \times 0.5 \times [0 + 1.1071 + 2(0.4636 + 0.7854 + 0.9828)] = 1.39$  (3sf) M1 A1 (7)
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3. (a)  $6x - 2 + y + x \frac{dy}{dx} + 2y \frac{dy}{dx} = 0$  M1 A2  
 $(-1, 3) \Rightarrow -6 - 2 + 3 - \frac{dy}{dx} + 6 \frac{dy}{dx} = 0, \frac{dy}{dx} = 1$  M1 A1  
grad of normal = -1  
 $\therefore y - 3 = -(x + 1)$  M1  
 $y = 2 - x$  A1  
(b) sub.  $\Rightarrow 3x^2 - 2x + x(2 - x) + (2 - x)^2 - 11 = 0$  M1  
 $3x^2 - 4x - 7 = 0$  A1  
 $(3x - 7)(x + 1) = 0$  M1  
 $x = -1$  (at P) or  $\frac{7}{3} \therefore (\frac{7}{3}, -\frac{1}{3})$  A1 (11)
- 
4. (a)  $\overrightarrow{AB} = \begin{pmatrix} 10 \\ -15 \\ 5 \end{pmatrix}, \therefore \mathbf{r} = \begin{pmatrix} 3 \\ 9 \\ -7 \end{pmatrix} + \lambda \begin{pmatrix} 2 \\ -3 \\ 1 \end{pmatrix}$  M1 A1  
(b)  $3 + 2\lambda = 9 \therefore \lambda = 3$  M1  
when  $\lambda = 3, \mathbf{r} = \begin{pmatrix} 3 \\ 9 \\ -7 \end{pmatrix} + 3 \begin{pmatrix} 2 \\ -3 \\ 1 \end{pmatrix} = \begin{pmatrix} 9 \\ 0 \\ -4 \end{pmatrix} \therefore (9, 0, -4)$  lies on  $l$  A1  
(c)  $\overrightarrow{OD} = \begin{pmatrix} 3+2\lambda \\ 9-3\lambda \\ -7+\lambda \end{pmatrix} \therefore \begin{pmatrix} 3+2\lambda \\ 9-3\lambda \\ -7+\lambda \end{pmatrix} \cdot \begin{pmatrix} 2 \\ -3 \\ 1 \end{pmatrix} = 0$  M1  
 $6 + 4\lambda - 27 + 9\lambda - 7 + \lambda = 0$  A1  
 $\lambda = 2 \therefore \overrightarrow{OD} = \begin{pmatrix} 7 \\ 3 \\ -5 \end{pmatrix}, D(7, 3, -5)$  M1 A1  
(d)  $AB = \sqrt{100 + 225 + 25} = \sqrt{350}, OD = \sqrt{49 + 9 + 25} + \sqrt{83}$  M1  
area =  $\frac{1}{2} \times \sqrt{350} \times \sqrt{83} = 85.2$  (3sf) M1 A1 (11)
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5. (a)  $\frac{d\theta}{dt} = -k(\theta - 20)$  B2
- (b)  $\int \frac{1}{\theta - 20} d\theta = \int -k dt$  M1  
 $\ln|\theta - 20| = -kt + c$  M1 A1  
 $t = 0, \theta = 37 \Rightarrow c = \ln 17$  M1  
 $\ln\left|\frac{\theta - 20}{17}\right| = -kt, \theta = 20 + 17e^{-kt}$  A1  
 $t = 4, \theta = 36 \Rightarrow 36 = 20 + 17e^{-4k}$  M1  
 $k = -\frac{1}{4} \ln \frac{16}{17} = 0.01516$  A1  
 $t = 10, \theta = 20 + 17e^{-0.01516 \times 10} = 34.6^\circ\text{C}$  (3sf) A1
- (c)  $33 = 20 + 17e^{-0.01516t}$  M1  
 $t = -\frac{1}{0.01516} \ln \frac{13}{17} = 17.70 \text{ minutes} = 17 \text{ mins } 42 \text{ secs}$  M1 A1 (13)

6. (a)  $x = 0 \Rightarrow t = 0$  at  $O$  B1  
 $y = 0 \Rightarrow t = 0$  (at  $O$ ) or  $\frac{\pi}{2} \therefore t = \frac{\pi}{2}$  at  $A$  B1
- (b) = volume when region above  $x$ -axis is rotated through  $2\pi$   
 $\frac{dx}{dt} = 3 \cos t$  M1  
 $\therefore \text{volume} = \pi \int_0^{\frac{\pi}{2}} (2 \sin 2t)^2 \times 3 \cos t dt = \int_0^{\frac{\pi}{2}} 12\pi \sin^2 2t \cos t dt$  M1 A1
- (c)  $t = 0 \Rightarrow u = 0, t = \frac{\pi}{2} \Rightarrow u = 1, \frac{du}{dt} = \cos t$  B1  
 $\sin^2 2t = 4 \sin^2 t \cos^2 t = 4 \sin^2 t (1 - \sin^2 t)$  M1  
 $\therefore = \int_0^1 12\pi \times 4u^2(1 - u^2) du$  M1  
 $= 48\pi \int_0^1 (u^2 - u^4) du$  A1  
 $= 48\pi \left[ \frac{1}{3} u^3 - \frac{1}{5} u^5 \right]_0^1$  M1 A1  
 $= 48\pi \left[ \left( \frac{1}{3} - \frac{1}{5} \right) - (0) \right] = \frac{32}{5} \pi$  M1 A1 (13)

7. (a)  $\frac{8-x}{(1+x)(2-x)} \equiv \frac{A}{1+x} + \frac{B}{2-x}$   
 $8-x \equiv A(2-x) + B(1+x)$  M1  
 $x = -1 \Rightarrow 9 = 3A \Rightarrow A = 3$  A1  
 $x = 2 \Rightarrow 6 = 3B \Rightarrow B = 2 \therefore f(x) = \frac{3}{1+x} + \frac{2}{2-x}$  A1
- (b)  $= \int_0^{\frac{1}{2}} \left( \frac{3}{1+x} + \frac{2}{2-x} \right) dx = \left[ 3 \ln|1+x| - 2 \ln|2-x| \right]_0^{\frac{1}{2}}$  M1 A1  
 $= \left( 3 \ln \frac{3}{2} - 2 \ln \frac{3}{2} \right) - (0 - 2 \ln 2)$  M1  
 $= \ln \frac{3}{2} + \ln 4 = \ln 6$  M1 A1
- (c)  $f(x) = 3(1+x)^{-1} + 2(2-x)^{-1}$   
 $(1+x)^{-1} = 1 - x + x^2 - x^3 + \dots$  B1  
 $(2-x)^{-1} = 2^{-1} \left( 1 - \frac{1}{2}x \right)^{-1}$  M1  
 $= \frac{1}{2} \left[ 1 + (-1)\left(-\frac{1}{2}x\right) + \frac{(-1)(-2)}{2} \left(-\frac{1}{2}x\right)^2 + \frac{(-1)(-2)(-3)}{3 \times 2} \left(-\frac{1}{2}x\right)^3 + \dots \right]$  M1  
 $= \frac{1}{2} \left( 1 + \frac{1}{2}x + \frac{1}{4}x^2 + \frac{1}{8}x^3 + \dots \right)$  A1  
 $\therefore f(x) = 3(1 - x + x^2 - x^3 + \dots) + \left( 1 + \frac{1}{2}x + \frac{1}{4}x^2 + \frac{1}{8}x^3 + \dots \right)$  M1  
 $= 4 - \frac{5}{2}x + \frac{13}{4}x^2 - \frac{23}{8}x^3 + \dots$  A1 (14)

Total (75)

