

Solomon Press
Core Mathematics C4
Paper K
(Mark Scheme)

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Mr.S.V.Swarnaraja (Marking Examiner, Team Leader & Author)
www.swanash.com, Mobile: +94777304755 , email: swa@swanash.com**

GCE Examinations
Advanced Subsidiary

Core Mathematics C4

Paper K

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.



Written by Shaun Armstrong

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C4 Paper K – Marking Guide

$$\begin{aligned}
 1. \quad &= \pi \int_1^3 \frac{(3x+1)^2}{x} \, dx && \text{M1} \\
 &= \pi \int_1^3 \frac{9x^2+6x+1}{x} \, dx = \int_1^3 (9x+6+\frac{1}{x}) \, dx && \text{A1} \\
 &= \pi \left[\frac{9}{2}x^2 + 6x + \ln|x| \right]_1^3 && \text{M1 A1} \\
 &= \pi \left\{ \left(\frac{81}{2} + 18 + \ln 3 \right) - \left(\frac{9}{2} + 6 + 0 \right) \right\} && \text{M1} \\
 &= \pi(48 + \ln 3) && \text{A1} \quad \mathbf{(6)}
 \end{aligned}$$

$$\begin{aligned}
 2. \quad (a) \quad &(1-3x)^{-2} = 1 + (-2)(-3x) + \frac{(-2)(-3)}{2}(-3x)^2 + \frac{(-2)(-3)(-4)}{3 \times 2}(-3x)^3 + \dots && \text{M1} \\
 &= 1 + 6x + 27x^2 + 108x^3 + \dots && \text{A3} \\
 (b) \quad &\left(\frac{2-x}{1-3x} \right)^2 = (2-x)^2(1-3x)^{-2} = (4-4x+x^2)(1+6x+27x^2+108x^3+\dots) && \text{M1} \\
 &= 4 + 24x + 108x^2 + 432x^3 - 4x - 24x^2 - 108x^3 + x^2 + 6x^3 + \dots && \text{A1} \\
 \therefore \text{ for small } x, &\left(\frac{2-x}{1-3x} \right)^2 = 4 + 20x + 85x^2 + 330x^3 && \text{A1} \quad \mathbf{(7)}
 \end{aligned}$$

$$\begin{aligned}
 3. \quad (a) \quad &\frac{7+3x+2x^2}{(1-2x)(1+x)^2} \equiv \frac{A}{1-2x} + \frac{B}{1+x} + \frac{C}{(1+x)^2} \\
 &7+3x+2x^2 \equiv A(1+x)^2 + B(1-2x)(1+x) + C(1-2x) \\
 x = \frac{1}{2} &\Rightarrow 9 = \frac{9}{4}A \Rightarrow A = 4 && \text{B1} \\
 x = -1 &\Rightarrow 6 = 3C \Rightarrow C = 2 && \text{B1} \\
 \text{coeffs } x^2 &\Rightarrow 2 = A - 2B \Rightarrow B = 1 && \text{M1} \\
 \therefore f(x) &= \frac{4}{1-2x} + \frac{1}{1+x} + \frac{2}{(1+x)^2} && \text{A1} \\
 (b) \quad &= \int_1^2 \left(\frac{4}{1-2x} + \frac{1}{1+x} + \frac{2}{(1+x)^2} \right) dx \\
 &= [-2 \ln|1-2x| + \ln|1+x| - 2(1+x)^{-1}]_1^2 && \text{M1 A3} \\
 &= (-2 \ln 3 + \ln 3 - \frac{2}{3}) - (0 + \ln 2 - 1) && \text{M1} \\
 &= -\ln 3 - \ln 2 + \frac{1}{3} = \frac{1}{3} - \ln 6 \quad [p = \frac{1}{3}, q = 6] && \text{M1 A1} \quad \mathbf{(11)}
 \end{aligned}$$

$$\begin{aligned}
 4. \quad (a) \quad &4\lambda = 6 + 14\mu \quad (1) \\
 &-3 - 2\lambda = 3 + 2\mu \quad (2) \\
 (1) + 2 \times (2): &-6 = 12 + 18\mu, \mu = -1, \lambda = -2 \\
 \mathbf{r} &= \begin{pmatrix} 7 \\ 0 \\ -3 \end{pmatrix} - 2 \begin{pmatrix} 5 \\ 4 \\ -2 \end{pmatrix} = \begin{pmatrix} -3 \\ -8 \\ 1 \end{pmatrix} && \text{M1 A1} \\
 (b) \quad &a - (-5) = -3, \quad a = -8 && \text{M1 A1} \\
 (c) \quad \cos \theta &= \frac{|5 \times (-5) + 4 \times 14 + (-2) \times 2|}{\sqrt{25+16+4} \times \sqrt{25+196+4}} && \text{M1 A1} \\
 &= \frac{27}{\sqrt{45} \times 15} = \frac{9}{3\sqrt{5} \times 5} = \frac{3}{5\sqrt{5}} = \frac{3}{25}\sqrt{5} && \text{M1 A1} \quad \mathbf{(11)}
 \end{aligned}$$

5. (a) $2x - 4y - 4x \frac{dy}{dx} + 4y \frac{dy}{dx} = 0$ M1 A2
- $$\frac{dy}{dx} = \frac{2x-4y}{4x-4y} = \frac{x-2y}{2x-2y}$$
- M1 A1
- (b) $\text{grad} = \frac{3}{2}$ M1
- $$\therefore y - 2 = \frac{3}{2}(x - 1)$$
- M1
- $$2y - 4 = 3x - 3$$
- $$3x - 2y + 1 = 0$$
- A1
- (c) $\frac{x-2y}{2x-2y} = \frac{3}{2}$ M1
- $$2(x - 2y) = 3(2x - 2y), \quad y = 2x$$
- A1
- sub. $\Rightarrow x^2 - 8x^2 + 8x^2 = 1$ M1
- $$x^2 = 1, \quad x = 1 \text{ (at } P) \text{ or } -1$$
- $$\therefore Q(-1, -2)$$
- A1 (12)
-

6. (a) $\frac{dN}{dt} = kN$ B1
- (b) $\int \frac{1}{N} dN = \int k dt$ M1
- $$\ln |N| = kt + c$$
- M1 A1
- $$t = 0, N = N_0 \Rightarrow \ln |N_0| = c$$
- M1
- $$\ln |N| = kt + \ln |N_0|, \quad \ln \left| \frac{N}{N_0} \right| = kt$$
- M1
- $$\frac{N}{N_0} = e^{kt}, \quad N = N_0 e^{kt}$$
- A1
- (c) $2N_0 = N_0 e^{6k}$ M1
- $$k = \frac{1}{6} \ln 2 = 0.116 \text{ (3sf)}$$
- M1 A1
- (d) $10N_0 = N_0 e^{0.1155t}$ M1
- $$t = \frac{1}{0.1155} \ln 10 = 19.932 \text{ hours} = 19 \text{ hours } 56 \text{ mins}$$
- M1 A1 (13)
-

7. (a) $x + \frac{1}{x} = \sec \theta + \tan \theta + \frac{1}{\sec \theta + \tan \theta} = \frac{(\sec \theta + \tan \theta)^2 + 1}{\sec \theta + \tan \theta}$ M1
- $$= \frac{\sec^2 \theta + 2 \sec \theta \tan \theta + \tan^2 \theta + 1}{\sec \theta + \tan \theta} = \frac{2 \sec^2 \theta + 2 \sec \theta \tan \theta}{\sec \theta + \tan \theta}$$
- M1 A1
- $$= \frac{2 \sec \theta (\sec \theta + \tan \theta)}{\sec \theta + \tan \theta} = 2 \sec \theta$$
- M1 A1
- (b) $\frac{x^2+1}{x} = \frac{2}{\cos \theta} \Rightarrow \cos \theta = \frac{2x}{x^2+1}$ M1
- $$\frac{y^2+1}{y} = \frac{2}{\sin \theta} \Rightarrow \sin \theta = \frac{2y}{y^2+1} \quad \therefore \frac{4x^2}{(x^2+1)^2} + \frac{4y^2}{(y^2+1)^2} = 1$$
- M1 A1
- (c) $\frac{dx}{d\theta} = \sec \theta \tan \theta + \sec^2 \theta$ M1
- $$= \sec \theta (\tan \theta + \sec \theta) = \frac{x^2+1}{2x} \times x = \frac{1}{2}(x^2+1)$$
- M1 A1
- (d) $\frac{dy}{d\theta} = -\operatorname{cosec} \theta \cot \theta - \operatorname{cosec}^2 \theta$ M1
- $$= -\operatorname{cosec} \theta (\cot \theta + \operatorname{cosec} \theta) = -\frac{y^2+1}{2y} \times y = -\frac{1}{2}(y^2+1)$$
- A1
- $$\therefore \frac{dy}{dx} = -\frac{y^2+1}{x^2+1}$$
- M1 A1 (15)
-

Total (75)