CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9709 MATHEMATICS

9709/11 Paper 1, maximum raw mark 75

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1	**(i)** $64 + 576x + 2160x^2$	**B1B1B1** **[3]**	Can score in (ii)
	(ii) $576a(x^2) + 2160(x^2) = 0$	**M1**	
	$a = -\frac{2160}{576}$ oe (eg $-\frac{15}{4}$) or −3.75	**A1** **[2]**	
2	Attempt integration	**M1**	
	$f(x) = 2(x+6)^{\frac{1}{2}} - \frac{6}{x}(+c)$	**A1A1**	Accept unsimplified terms
	$2(3) - \frac{6}{3} + c = 1$	**M1**	Sub.x = 3, y = 1. c must be present
	$c = -3$	**A1** **[5]**	
3	**(i)** **DB** = 6**i** + 4**j** – 3**k** cao **DE** = 3**i** +2**j** – 3**k** cao	**B1** **B1** **[2]**	
	(ii) **DB.DE** = 18 + 8 + 9 = 35	**M1**	Use of $x_1x_2 + y_1y_2 + z_1z_2$
	$\lvert \mathbf{DB} \rvert = \sqrt{61}$ or $\lvert \mathbf{DE} \rvert = \sqrt{22}$	**M1**	Correct method for moduli
	$35 = \sqrt{61} \times \sqrt{22} \times \cos\theta$ oe	**M1**	All connected correctly
	$\theta = 17.2°$ (0.300 rad) cao	**A1** **[4]**	Use of e.g. **BD. DE** can score M marks (leads to obtuse angle)
4	**(i)** $4(1 - \cos^2 x) + 8\cos x - 7 = 0$	**M1**	Use $c^2 + s^2 = 1$
	$4c^2 - 8c + 3 = 0 \rightarrow (2\cos x - 1)(2\cos x - 3) = 0$	**M1**	Attempt to solve
	$x = 60°$ or $300°$	**A1A1** **[4]**	
	(ii) $\frac{1}{2}\theta = 60°$ (or 300°)	**M1**	Allow 300° in addition
	$\theta = 120°$ only	**A1** **[2]**	
5	**(i)** $x = (\pm)\sqrt{y-1}$	**B1**	**OR** $y^2 = x - 1$ (x/y interchange 1st)
	$f^{-1} : x \mapsto \sqrt{x-1}$ for $x > 1$	**B1B1** **[3]**	
	(ii) $ff(x) = (x^2+1)^2 + 1$	**B1**	Or $x^4 + 2x^2 - (153/16) = 0$
	$x^2 + 1 = (\pm)13/4$	**M1**	Or $x^2 = 9/4, (-17/4)$
	$x = 3/2$	**A1** **[3]**	www. Condone ± 3/2
Alt. (ii)	$f(x) = f^{-1}(185/16) = 13/4$	**M1**	**Alt.**(ii) f(3/2) = 13/4 **B1**
	$x = f^{-1}(13/4)$	**M1**	f(13/4) = 185/16 **B1**
	$x = 3/2$	**A1**	x = 3/2 **B1**
			SC.B2 answer 1.5 with no working

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6	**(i)** $r(2\pi - \alpha)$ $+ 2r\alpha + 2r$ $2\pi r + r\alpha + 2r$	**B1B1** **B1√** **[3]**	ft for $r\alpha$ instead of $2r\alpha$ or omission $2r$ SC1 for $2r\alpha + 4r$. (Plate = shaded part)
	(ii) $\frac{1}{2}(2r)^2\alpha + \pi r^2 - \frac{1}{2}r^2\alpha$ $\frac{3r^2\alpha}{2} + \pi r^2$	**B1B1** **B1** **[3]**	Either B1 can be scored in (iii)
	(iii) $\pi r^2 - \frac{1}{2}r^2\alpha = 2r^2\alpha$ $\alpha = \frac{2}{5}\pi$	**M1** **A1** **[2]**	For equating *their* 2 parts from (ii)
7	**(i)** mid-point = (3, 4) Grad. $AB = -½ \rightarrow$ grad. of perp., = 2 $y - 4 = 2(x - 3)$ $y = 2x - 2$	**B1** **M1** **M1** **A1** **[4]**	soi For use of $-1/m$ soi ft on *their* (3, 4) and 2
	(ii) $q = 2p - 2$ √ $\quad p^2 + q^2 = 4$ oe $p^2 + (2p-2)^2 = 4 \rightarrow 5p^2 - 8p = 0$ {OR¼ $(q+2)^2 + q^2 = 4 \rightarrow 5q^2 + 4q - 12 = 0$ } (0,−2) and $\left(\frac{8}{5}, \frac{6}{5}\right)$	**B1√ B1** **M1** **A1A1** **[5]**	ft for 1st eqn. Attempt substn (linear into quadratic) & simplify
8	**(i)** $A = 2xr + \pi r^2$ $2x + 2\pi r = 400 \ (\Rightarrow x = 200 - \pi r)$ $A = 400r - \pi r^2$	**B1** **B1** **M1A1** **[4]**	Subst & simplify to **AG** (www)
	(ii) $\frac{dA}{dr} = 400 - 2\pi r$ $= 0$ $r = \frac{200}{\pi}$ oe $x = 0 \Rightarrow$ no straight sections **AG** $\frac{d^2A}{dr^2} = -2\pi \quad (< 0)$ Max	**B1** **M1** **A1** **A1** **B1** **[5]**	Differentiate Set to zero and attempt to find r Dep on -2π, or use of other valid reason

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9	**(a)** $\frac{10}{2}(2a+9d)=400$ oe	**B1**	$\rightarrow 2a+9d=80$
	$\frac{20}{2}(2a+19d)=1400$ OR		
	$\frac{10}{2}[2(a+10d)+9d]=1000$	**B1**	$\rightarrow 2a+19d=140$ or $2a+29d=200$
	$d=6 \quad a=13$	**M1A1A1** **[5]**	Solve sim. eqns both from S_n formulae
	(b) $\frac{a}{1-r}=6$ $\qquad$ $\frac{2a}{1-r^2}=7$	**B1B1**	
	$\frac{12(1-r)}{1-r^2}=7$ or $\frac{1-r^2}{1-r}=\frac{12}{7}$	**M1**	Substitute or divide
	$r=\frac{5}{7}$ or 0.714	**A1**	
	$a=\frac{12}{7}$ or 1.71(4)	**A1** **[5]**	Ignore any other solns for *r* and *a*
10	**(i)** $\frac{dy}{dx}=\left[3(3-2x)^2\right]\times[-2]$	**B1B1**	OR $-54+72x-24x^2$ B2,1,0
	At $x=\frac{1}{2}, \frac{dy}{dx}=-24$	**M1**	
	$y-8=-24\left(x-\frac{1}{2}\right)$	**DM1**	
	$y=-24x+20$	**A1** **[5]**	
	(ii) Area under curve $=\left[\frac{(3-2x)^4}{4}\right]\times\left[-\frac{1}{2}\right]$	**B1B1**	OR $27x-27x^2+12x^3-2x^4$ B2,1,0
	$-2-\left(-\frac{81}{8}\right)$	**M1**	Limits 0→ ½ applied to integral with intention of subtraction shown
	Area under tangent = $\int(-24x+20)$	**M1**	or area trap =½(20 + 8) × ½
	$=\left\lvert -12x^2+20x \right\rvert$ or 7 (from trap)	**A1**	Could be implied
	$\frac{9}{8}$ or 1.125	**A1** **[6]**	Dep on both M marks

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1	**(i)** $\sin x = \sqrt{(1-p^2)}$	B1 [1]	Allow $1-p$ if following $\sqrt{(1-p^2)}$ ± is B0.
	(ii) $\tan x = \dfrac{\sin x}{\cos x} = \dfrac{\sqrt{1-p^2}}{p}$	B1√ [1]	√ for answer to **(i)** used.
	(iii) $\tan(90-x) = \dfrac{p}{\sqrt{1-p^2}}$	B1√ [1]	√ for reciprocal of **(ii)**
2	**(i)** slant length = 10 cm. circumference of base = 12π arc length = 10θ (= 12π) $\rightarrow \theta = 1.2\pi$ or 3.77 radians.	B1 B1 B1√ B1 [4]	Use of $r\theta$, θ calculated, not 6 or 8.
	(ii) $\frac{1}{2}r^2\theta = 188.5$ cm ^{2} or 60π.	M1 A1√ [2]	Use of $\frac{1}{2}r^2\theta$ with radians and r = calculated '10', not 6 or 8.
3	$y = \dfrac{2}{\sqrt{5x-6}}$ **(i)** $\dfrac{dy}{dx} = 2 \times -\frac{1}{2} \times (5x-6)^{-\frac{3}{2}} \times 5$ $\rightarrow -\frac{5}{8}$	B1 B1 B1 [3]	B1 without '×5'. B1 For '×5' Use of 'uv' or 'u/v' ok.
	(ii) integral = $\dfrac{2\sqrt{5x-6}}{\frac{1}{2}} \div 5$ Uses 2 to 3 $\rightarrow$ 2.4 − 1.6 = 0.8	B1 B1 M1 A1 [4]	B1 without '÷5'. B1 for '÷ 5' Use of limits in an integral.
4	$\overrightarrow{OA} = \mathbf{i} + 2\mathbf{j}$ and $\overrightarrow{OB} = 4\mathbf{i} + p\mathbf{k}$, **(i)** $\overrightarrow{AB} = \mathbf{b} - \mathbf{a} = 3\mathrm{i} - 2\mathrm{j} + 6\mathrm{k}$ Unit vector = $(3\mathrm{i} - 2\mathrm{j} + 6\mathrm{k}) \div 7$	B1 M1 A1√ [3]	Must be $\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$ Divides by modulus. √ on vector AB.
	(ii) Scalar product = 4 $= \sqrt{5} \times \sqrt{(16+p^2)} \times \cos\theta$ $\rightarrow p = \pm 8$	M1 M1 M1 A1 [4]	Use of $x_1x_2 + y_1y_2 + z_1z_2$ For modulus. All linked correctly including correct use of $\cos\theta = 1/5$.
5	A (0, 8) B (4, 0) $8y + x = 33$ m of $AB = -2$ m of $BC = \frac{1}{2}$ Eqn $BC \rightarrow y - 0 = \frac{1}{2}(x-4)$ Sim eqns $\rightarrow C$ (16, 6) Vector step method $\rightarrow D$ (12, 14) (or AD $y = \frac{1}{2}x + 8$, CD $y = -2x + 38$) (or M = (8, 7) $\rightarrow D$ = (12, 14))	B1 M1 M1 M1 A1 M1 A1 [7]	Use of $m_1m_2 = -1$ for BC or AD Correct method for equation of BC Sim Eqns for BC, AC. M1 valid method.

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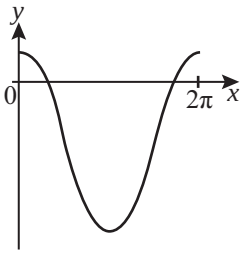
6		
(i) Sim triangles $\frac{y}{16-x}=\frac{12}{16}$ (or trig) $\rightarrow y = 12 - \frac{3}{4}x$ $A = xy = 12x - \frac{3}{4}x^2$.	M1 A1 A1 [3]	Trig, similarity or eqn of line (could also come from eqn of line) ag – check working.
(ii) $\frac{dA}{dx} = 12 - \frac{6x}{4}$ $= 0$ when $x = 8$. $\rightarrow A = 48$. This is a Maximum. From −ve quadratic or 2nd differential.	B1 M1 A1 B1 [4]	 Sets to 0 + solution. Can be deduced without any working. Allow even if '48' incorrect.
7 **(a)** **(i)** $a = 300$, $d = 12$ $\rightarrow 540 = 300 + (n-1)12 \rightarrow n = 21$	M1 A1 [2]	Use of nth term. Ans 20 gets 0. Ignore incorrect units
(ii) $S_{26} = 13\,(600 + 25\times12) = 11700$ $\rightarrow$ 3 hours 15 minutes.	M1 A1 [2]	Correct use of s_n formula.
(b) $ar = 48$ and $ar^2 = 32 \rightarrow r = \frac{2}{3}$ $\rightarrow a = 72$. $S_\infty = 72 \div \frac{1}{3} = 216$.	M1 A1 M1 A1√ [4]	Needs ar and ar^2 + attempt at a and r. Correct S_∞ formula with $\lvert r \rvert < 1$
8 $f : x \mapsto 3\cos x - 2$ for $0 \leqslant x \leqslant 2\pi$.		
(i) $3\cos x - 2 = 0 \rightarrow \cos x = \frac{2}{3}$ $\rightarrow x = 0.841$ or 5.44	M1 A1 A1√ [3]	Makes cos subject, then $\cos^{-1}$ √ for 2π − 1st answer.
(ii) range is $-5 \leqslant f(x) \leqslant 1$	B2,1 [2]	B1 for $\geqslant -5$. B1 for $\leqslant 1$.
(iii)  	B1,B1 [2]	B1 starts and ends at same point. Starts decreasing. One cycle only. B1 for shape, not 'V' or 'U'.
(iv) max value of $k = \pi$ or 180°.	B1 [1]	
(iv) $g^{-1}(x) = \cos^{-1}\left(\frac{x+2}{3}\right)$	M1 A1 [2]	Make x the subject, copes with 'cos'. Needs to be in terms of x.

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9 $y = \frac{8}{x} + 2x$		
(i) $\frac{dy}{dx} = \frac{-8}{x^2} + 2$ $(-6$ at $A)$ $\frac{dy}{dt} = \frac{dy}{dx} \times \frac{dy}{dt}$ $\rightarrow -0.24$	M1 A1 M1 A1 [4]	Attempt at differentiation. algebraic – unsimplified. Ignore notation – needs product of 0.04 and 'his' $\frac{dy}{dx}$.
(ii) $\int y^2 = \int \frac{64}{x^2} + 4x^2 + 32$ $= (\frac{-64}{x} + \frac{4x^3}{3} + 32x\ )$ Limits 2 to 5 used correctly $\rightarrow 271.2\pi$ or 852 (allow 271π or 851 to 852)	M1 A3,2,1 DM1 A1 [6]	Use of integral of y^2 (ignore π) 3 terms $\rightarrow -1$ each error. Uses correct limits correctly. (omission of π loses last mark)
10 $f: x \mapsto 2x^2 - 3x$, $g: x \mapsto 3x + k$,		
(i) $2x^2 - 3x - 9 > 0$ $\rightarrow x = 3$ or $-1½$ Set of x $x > 3$, or $x < -1½$	M1 A1 A1 [3]	For solving quadratic. Ignore > or ⩾ condone ⩾ or ⩽
(ii) $2x^2 - 3x = 2(x - \frac{3}{4})^2 - \frac{9}{8}$ Vertex $(\frac{3}{4}, -\frac{9}{8})$	B3,2,1 B1√ [4]	$-x^2$ in bracket is an error. √ on 'c' and 'b'.
(iii) $gf(x) = 6x^2 - 9x + k = 0$ Use of $b^2 - 4ac \rightarrow k = \frac{27}{8}$ oe.	B1 M1 A1 [3]	 Used on a quadratic (even fg).

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PA –1 This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

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1	$(x + 1)(x - 2)$ or other valid method $-1, 2$ $x < -1, x > 2$	M1 A1 A1 [3]	Attempt soln of eqn or other method Penalise $\leq, \geq$
2	$f(x) = 2x^{-\frac{1}{2}} + x\ (+c)$ $5 = -2 \times \frac{1}{2} + 4 + c$ $c = 2$	M1A1 M1 A1 [4]	Attempt integ $x^{-\frac{1}{2}}$ or $+x$ needed for M Sub (4, 5). c must be present
3	**(i)** gradient of perpendicular = $-\frac{1}{2}$ soi $y - 1 = -\frac{1}{2}(x - 3)$	B1 B1 [2]	
	(ii) $C = (-9, 6)$ $AC^2 = [3 - (-9)]^2 + [1 - 6]^2$ (ft on *their C*) $AC = 13$	B1 M1 A1 [3]	soi in **(i)** or **(ii)** **OR** $AB^2 = [3-(-21)]^2 + [1-11]^2$ M1 $AB = 26$ A1 $AC = 13$ A1
4	**(i)** $\mathbf{OD} = 4\mathbf{i} + 3\mathbf{j}$ $\mathbf{CD} = 4\mathbf{i} + 3\mathbf{j} - 10\mathbf{k}$	B1 B1√ [2]	√ for $\mathbf{OD} - \mathbf{10k}$
	(ii) $\mathbf{OD}.\mathbf{CD} = 9 + 16 = 25$ $\lvert\mathbf{OD}\rvert = \sqrt{25}$ or $\lvert\mathbf{CD}\rvert = \sqrt{125}$ $25 = \sqrt{25} \times \sqrt{125} \times \cos\theta$ oe ODC = 63.4° (or 1.11 rads)	M1 M1 M1 A1 [4]	Use of $x_1x_2 + y_1y_2 + z_1z_2$ Correct method for moduli All connected correctly cao
5	**(a)** $\frac{a}{1-r} = 8a \Rightarrow 1(a) = 8(a)(1-r)$ $r = \frac{7}{8}$ oe	B1 B1 [2]	
	(b) $a + 4d = 197$ $\frac{10}{2}[2a + 9d] = 2040$ $d = 14$	B1 B1 M1A1 [4]	Or $2a + 9d = 408$ Attempt to solve simultaneously
6	**(i)** sector areas are $\frac{1}{2}11^2\alpha, \frac{1}{2}5^2\alpha$ $k = \frac{\frac{1}{2} \times 11^2\alpha - \frac{1}{2} \times 5^2\alpha}{\frac{1}{2} \times 5^2\alpha}$ $k = \frac{96}{25}$ or 3.84	B1 M1 A1 [3]	Sight of $11^2, 5^2$ Or $\frac{11^2 - 5^2}{5^2}$

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	(ii) perimeter shaded region= $11\alpha + 5\alpha + 6 + 6 = 16\alpha + 12$ perimeter unshaded region = $5\alpha + 5 + 5 = 5\alpha + 10$ $16\alpha + 12 = 2(5\alpha + 10)$ $\alpha = 4/3$ or 1.33	B1 B1 M1 A1 [4]	
7	**(a)** $x^2 - 1 = \sin\frac{\pi}{3}$ $x = \pm 1.366$	M1 A1A1√ [3]	√ for negative of 1st answer
	(b) $2\theta + \frac{\pi}{3} = \frac{5\pi}{6}\left(\text{or } \frac{13\pi}{6} \text{ or } \frac{\pi}{6}\right)$ $2\theta = \frac{\pi}{2} = \left(\text{or } \frac{11\pi}{6}\right)$ $\theta = \frac{\pi}{4}, \frac{11\pi}{12}$	B1 M1 A1A1 [4]	1 correct angle on RHS is sufficient Isolating 2θ SC decimals 0.785 & 2.88 scores M1B1
8	**(i)** 81 (x^8)	B1 [1]	
	(ii) 10×3^3 (x^8) soi leading to their answer 270 (x^8)	B1B1 B1 [3]	B1 for 10, 5C2 or 5C3. B1 for 3^3. But must be multiplied.
	(iii) k × **(i)** 405 soi + **(ii)** 675 (x^8)	M1 A1 DM1 A1 [4]	$k \neq 1,0$
9	$\frac{dy}{dx} = -k^2(x+2)^{-2} + 1 = 0$ $x + 2 = \pm k$ $x = -2 \pm k$ $\frac{d^2y}{dx^2} = 2k^2(x+2)^{-3}$ When $x = -2 = k$, $\frac{d^2y}{dx^2} = \left(\frac{2}{k}\right)$ which is (> 0) min When $x = -2 - k$, $\frac{d^2y}{dx^2} = \left(\frac{2}{-k}\right)$ which is (< 0) max	M1A1 DM1 A1 M1 M1 A1 A1 [8]	Attempt differentiation & set to zero Attempt to solve cao Attempt to differentiate again Sub their x value with k in it into $\frac{d^2y}{dx^2}$ Only 1 of bracketed items needed for each but $\frac{d^2y}{dx^2}$ and x need to be correct.

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10	**(i)** Range is (y) $\geq c^2 + 4c$	B1	Allow >
	$x^2 + 4x = (x + 2)^2 - 4$	M1	**OR** $\frac{dy}{dx} = 2x + 4 = 0$
	(Smallest value of c is) -2	A1 [3]	-2 with no (wrong) working gets B2
	(ii) $5a + b = 11$	B1	
	$(a + b)^2 + 4(a + b) = 21$	B1	
	$(11 - 5a + a)^2 + 4(11 - 5a + a) = 21$	M1	**OR** corresponding equation in b
	$(8)(2a^2 - 13a + 18) = (8)(2a - 9)(a - 2) = 0$	M1	**OR** $(8)(2b + 23)(b - 1) = 0$
	$a = \frac{9}{2}, 2$ OR $b = \left(-\frac{23}{2}\right), 1$	A1 A1 [6]	A1 for either a or b correct. Condone 2nd value. Spotted solution scores only B marks.
	Alt. **(ii)** Last 5 marks		
	$f^{-1}(x) = \sqrt{x+4} - 2$ B1		**Alt. (ii)** Last 4 marks
	$g(1) = f^{-1} = (21)$ used M1		$(a + b + 7)(a + b - 3) = 0$ M1A1
	$a + b = \sqrt{25} - 2 = 3$ A1		(Ignore solution involving $a + b = -7$)
	Solve $a + b = 3, 5a + b = 11$ M1		Solve $a + b = 3, 5a + b = 11$ M1
	$a = 2, b = 1$ A1		$a = 2, b = 1$ A1
11	**(i)** $\frac{dy}{dx} = \left[\frac{1}{2}\left(x4 + 4x + 4\right)^{-\frac{1}{2}}\right] \times \left[4x^3 + 4\right]$	B1B1	
	At $x = 0$, $\frac{dy}{dx} = \frac{1}{2} \times \frac{1}{2} \times 4 = (1)$	M1	Sub $x = 0$ and attempt eqn of line following differentiation.
	Equation is $y - 2 = x$	A1 [4]	
	(ii) $x + 2 = \sqrt{x^4 + 4x + 4} \Rightarrow (x + 2)^2$	B1	**AG** www
	$= x4 + 4x + 4$		
	$x^2 - x^4 = 0$ oe	B1	
	$x = 0, \pm 1$	B2,1,0 [4]	
	(iii) $(\pi)\left[\frac{x^5}{5} + 2x^2 + 4x\right]$	M1A1	Attempt to integrate y^2
	$(\pi)\left[0 - \left(\frac{-1}{5} + 2 - 4\right)\right]$	DM1	
	$\frac{11\pi}{5}$ (6.91) oe	A1 [4]	Apply limits $-1 \rightarrow 0$

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