OCR
RECOGNISING ACHIEVEMENT

Friday 18 January 2013 – Afternoon

AS GCE MATHEMATICS

4722/01 Core Mathematics 2

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4722/01
- List of Formulae (MF1)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

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INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found in the centre of the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.

INFORMATION FOR CANDIDATES

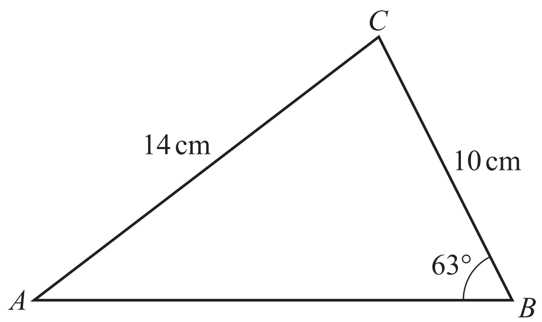
This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- **You are reminded of the need for clear presentation in your answers.**
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

INSTRUCTIONS TO EXAMS OFFICER/INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

1



The diagram shows triangle ABC, with $AC = 14$ cm, $BC = 10$ cm and angle $ABC = 63°$.

(i) Find angle CAB. **[2]**

(ii) Find the length of AB. **[2]**

2 A sequence $u_1, u_2, u_3, \ldots$ is defined by

$$u_1 = 7 \quad \text{and} \quad u_{n+1} = u_n + 4 \ \text{ for } n \geqslant 1.$$

(i) Show that $u_{17} = 71$. **[2]**

(ii) Show that $\sum_{n=1}^{35} u_n = \sum_{n=36}^{50} u_n$. **[4]**

3 A curve has an equation which satisfies $\frac{dy}{dx} = kx(2x - 1)$ for all values of x. The point P (2, 7) lies on the curve and the gradient of the curve at P is 9.

(i) Find the value of the constant k. **[2]**

(ii) Find the equation of the curve. **[5]**

4 **(i)** Find the binomial expansion of $(2 + x)^5$, simplifying the terms. **[4]**

(ii) Hence find the coefficient of y^3 in the expansion of $(2 + 3y + y^2)^5$. **[3]**

5 **(i)** Show that the equation $2\sin x = \frac{4\cos x - 1}{\tan x}$ can be expressed in the form

$$6\cos^2 x - \cos x - 2 = 0.$$ **[3]**

(ii) Hence solve the equation $2\sin x = \frac{4\cos x - 1}{\tan x}$, giving all values of x between 0° and 360°. **[4]**

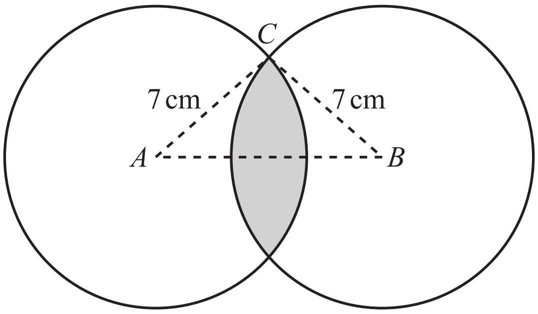
6 **(i)** The first three terms of an arithmetic progression are $2x$, $x + 4$ and $2x - 7$ respectively. Find the value of x. **[3]**

(ii) The first three terms of another sequence are also $2x$, $x + 4$ and $2x - 7$ respectively.

(a) Verify that when $x = 8$ the terms form a geometric progression and find the sum to infinity in this case. **[4]**

(b) Find the other possible value of x that also gives a geometric progression. **[4]**

7



The diagram shows two circles of radius 7 cm with centres A and B. The distance AB is 12 cm and the point C lies on both circles. The region common to both circles is shaded.

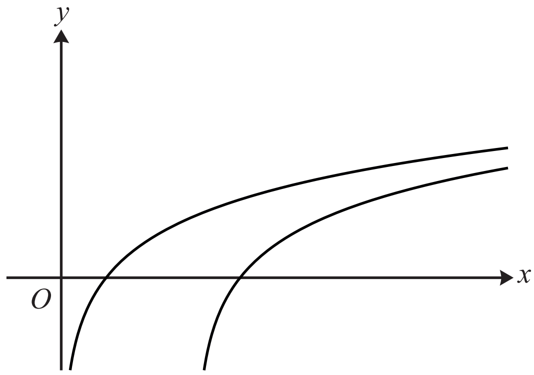
(i) Show that angle CAB is 0.5411 radians, correct to 4 significant figures. **[2]**

(ii) Find the perimeter of the shaded region. **[2]**

(iii) Find the area of the shaded region. **[5]**

[Questions 8 and 9 are printed overleaf.]

8



The diagram shows the curves $y = \log_2 x$ and $y = \log_2 (x - 3)$.

(i) Describe the geometrical transformation that transforms the curve $y = \log_2 x$ to the curve $y = \log_2 (x - 3)$. **[2]**

(ii) The curve $y = \log_2 x$ passes through the point $(a, 3)$. State the value of a. **[1]**

(iii) The curve $y = \log_2 (x - 3)$ passes through the point $(b, 1.8)$. Find the value of b, giving your answer correct to 3 significant figures. **[2]**

(iv) The point P lies on $y = \log_2 x$ and has an x-coordinate of c. The point Q lies on $y = \log_2 (x - 3)$ and also has an x-coordinate of c. Given that the distance PQ is 4 units find the exact value of c. **[4]**

9 The positive constant a is such that $\int_a^{2a} \frac{2x^3 - 5x^2 + 4}{x^2} \, dx = 0$.

(i) Show that $3a^3 - 5a^2 + 2 = 0$. **[6]**

(ii) Show that $a = 1$ is a root of $3a^3 - 5a^2 + 2 = 0$, and hence find the other possible value of a, giving your answer in simplified surd form. **[6]**

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Question			Answer	Marks	Guidance	
1	(i)		$\frac{\sin A}{10} = \frac{\sin 63}{14}$ $A = 39.5^o$	M1	Attempt use of correct sine rule	Must be correct sine rule, either way up Need to rearrange at least as far as sin A = ..., using a valid method Allow M1 even if subsequently evaluated in rads (0.120)
				A1 **[2]**	Obtain 39.5°, or better	Actual answer is 39.52636581... so allow more accurate answer as long as it rounds to 39.53
1	(ii)		$c^2 = 10^2 + 14^2 - 2\text{x}10\text{x}14\text{x}\cos 77.5^o$ c = 15.3	M1	Attempt use of correct cosine rule, or equiv, inc attempt at 77.5°	Angle used must be 77.5° or must come from a clear attempt at 180 - (63 + their A). **NB** Using 102.5° in sine rule will give 15.3, but this is M0. Must be correct formula seen or implied, but allow slip when evaluating eg omission of 2, incorrect extra 'big bracket' Allow M1 if expression is not square rooted, as long as LHS was intended to be correct ie $c^2 = \ldots$ or $AB^2 = \ldots$ Allow M1 even if subsequently evaluated in rad mode Allow any equiv method, including sine rule (as far as sin C = ...) or right-angled triangle trig (must be full and valid method)
				A1 **[2]**	Obtain 15.3, or better	Allow more accurate answer as long as it rounds to 15.34

Question			Answer	Marks	Guidance	
2	(i)		7 + 16 x 4 = 71 **AG**	M1	Attempt to find 17th term in the given AP	Attempt to use $u_n = a + (n - 1)d$ with $a = 7$ and $d = 4$ Allow a more informal method, including writing out the sequence with $a = 7$ and $d = 4$ Could also attempt u_{17} from attempt at $u_n = 4n + 3$ – must be seen explicitly
				A1	Show clear detail to obtain $u_{17} = 71$	If listing terms, 71 must either be last number in list or clearly identified eg underlined
				[2]		
2	(ii)		$S_{35} = {}^{35}/_2\,(2 \text{ x } 7 + 34 \text{ x } 4)$ $= 2625$	M1	Attempt sum of first 35 terms of given AP	Must use correct formula, with $a = 7$ and $d = 4$ If using $½n\,(a + l)$ then must be valid attempt at l Could use $4\sum n + \sum 3$, but M0 for $4\sum n + 3$
				A1	Obtain 2625	Must be evaluated Allow M1A1 for 2625 from no working
			either $S_{50} = {}^{50}/_2\,(2 \text{ x } 7 + 49 \text{ x } 4)$ $= 5250$ $5250 - 2625 = 2625$ **AG** or $S_{36-50} = {}^{15}/_2\,(2 \text{ x } 147 + 14 \text{ x } 4)$ $= 2625$ **AG**	M1	Attempt a correct method to show given relationship	Must show explicit calculation so M0 for just stating eg $S_{50} = 5250$ Could sum first 50 terms of AP **and** find the difference between this and the sum of the first 35 terms, or equiv Could attempt to sum terms from u_{36} to u_{50} but M0 if summing from u_{35} (= 143)
				A1	Show given equality convincingly	No need for explicit conclusion once both sums shown to be 2625
				[4]		

Question			Answer	Marks	Guidance	
3	(i)		$2k \times 3 = 9$ $k = 1.5$	M1	Attempt to find k	Substitute $x = 2$ and $^{dy}/_{dx} = 9$ into given differential equation and attempt to find k
				A1	Obtain $k = 1.5$	Allow any exact equiv. including $^9/_6$
				[2]		
3	(ii)		$y = x^3 - 0.75x^2 + c$ $7 = 8 - 3 + c$ hence $c = 2$ $y = x^3 - 0.75x^2 + 2$	M1	Expand bracket and attempt integration	M0 if bracket not expanded first M1 can still be gained for integrating an incorrect expansion as long as there are two terms For an 'integration attempt' there must be an increase in power by 1 for both terms
				A1ft	Obtain at least one correct term (allow still in terms of k)	Follow through on their value of k (but not on an incorrect expansion at start of part (ii)) Can also get A1 if still in terms of k Allow unsimplified coefficients
				A1	Obtain $x^3 - 0.75x^2$ (condone no $+ c$)	Must now be numerical, and no f-t Allow unsimplified coefficients A0 if integral sign or dx still present, unless it later disappears
				M1	Attempt to find c using (2, 7)	There must have been an attempt at integration, but can follow M0 eg if the bracket was not expanded first Need to get as far as actually attempting c M1 could be implied by eg $7 = 8 - 3$ followed by an attempt to include a constant to balance the equation M0 if no $+ c$ seen or implied M0 if using $x = 7$, $y = 2$
				A1	Obtain $y = x^3 - 0.75x^2 + 2$	Coefficients now need to be simplified (0.75 or $^3/_4$) Must be an equation ie $y = ...$, so A0 for 'f(x) = ...' or 'equation = ...' Allow aef, such as $4y = 4x^3 - 3x^2 + 8$
				[5]		

Question			Answer	Marks	Guidance	
4	(i)		$(2 + x)^5 = 32 + 80x + 80x^2 + 40x^3 + 10x^4 + x^5$	M1*	Attempt expansion resulting in at least 5 terms – products of powers of 2 and x	Each term must be an attempt at a product, including binomial coeffs if used Allow M1 for no, or incorrect, binomial coeffs Powers of 2 and x must be intended to sum to 5 within each term (allow slips if intention correct) Allow M1 for powers of $\frac{1}{2}x$ from expanding $k(1 + \frac{1}{2}x)^5$, any k (allow if powers only applied to x and not ½)
				M1d*	Attempt to use correct binomial coefficients	At least 5 correct from 1, 5, 10, 10 , 5, 1 - allow missing or incorrect (but not if raised to a power) May be implied rather than explicit Must be numerical eg $^5C_1$ is not enough They must be part of a product within each term The coefficient must be used in an attempt at the relevant term ie 5 x 2^3 x x^3 is M0 Allow M1 for correct coeffs from $k(1 + \frac{1}{2}x)^5$, any k
				A1	Obtain at least 4 correct simplified terms	Either linked by '+' or as part of a list
				A1	Obtain a fully correct expansion	Terms must be linked by '+' and not just commas A0 if a correct expansion is subsequently spoiled by attempt to simplify, including division **SR for expanding brackets:** M2 - for attempt using all 5 brackets giving a quintic A1 - obtain at least 4 correct simplified terms A1 - obtain a fully correct expansion
				[4]		

Question			Answer	Marks	Guidance	
4	(ii)		$80\,(3y + y^2)^2 + 40\,(3y + y^2)^3$ coeff of y^3 = (80 x 6) + (40 x 27) = 1560	M1	Attempt to use $x = 3y + y^2$	Replace x with $3y + y^2$ in at least one relevant term and attempt expansion, including relevant numerical coeff from (i) or from restart
				A1	Obtain $480(y^3)$ or $1080(y^3)$	Could be with other terms, inc y^3
				A1	Obtain 1560 (or $1560y^3$)	Ignore terms involving powers other than y^3
			OR $(1 + y)^5(2 + y)^5$ $= (1 + 5y + 10y^2 + 10y^3 \ldots)$ x $(32 + 80y + 80y^2 + 40y^3 \ldots)$ coeff of y^3 = 320 + 800 + 400 + 40			**OR** M1- attempt expansion of both $(1 + y)^5$ and $(2 + y)^5$ (allow powers higher than 3 to be discarded) and make some attempt at the product A1 - obtain at least 2 correct coeffs of y^3 A1 - obtain 1560 (or $1560y^3$)
			OR $((2 + 3y) + y^2)^5$ $= (2 + 3y)^5 + 5(2 + 3y)^4y^2$ $= \ldots$ 10 x 4 x $27y^3 \ldots$ + 5 x 4 x 8 x $3y$ x y^2 coeff of y^3 = 1080 + 480 = 1560			**OR** M1 – attempt expansion of at least one relevant term A1 - obtain $480(y^3)$ or $1080(y^3)$ A1 - obtain 1560 (or $1560y^3$) **OR** M1 – attempt expansion of all 5 brackets (allow powers higher than 3 to be discarded throughout method) A2 – obtain 1560 (or $1560y^3$)
				[3]		

Question			Answer	Marks	Guidance	
5	(i)		$2\sin x\ {}^{\sin x}/_{\cos x} = 4\cos x - 1$ $2\sin^2 x = 4\cos^2 x - \cos x$ $2 - 2\cos^2 x = 4\cos^2 x - \cos x$ $6\cos^2 x - \cos x - 2 = 0$ **AG**	M1	Use $\tan x = {}^{\sin x}/_{\cos x}$ and rearrange to a form not involving fractions	Must be used and not just stated Must multiply all terms by $\cos x$ so $4\cos^2 x - 1$ is M0, but allow M1 for $\cos x(4\cos x - 1)$ even if subsequent errors
				M1	Use $\sin^2 x = 1 - \cos^2 x$	Must be used and not just stated Must be used correctly, so M0 for $1 - 2\cos^2 x$ Not dependent on previous M mark, so M0 M1 possible Must be attempting quadratic in $\cos x$ so M0 for $\cos^2 x = 1 - \sin^2 x$
				A1	Obtain $6\cos^2 x - \cos x - 2 = 0$ with no errors seen	Must be equation ie = 0 Allow poor notation (eg cos not cos$x$, or tan$x$ = ${}^{\sin}/_{\cos}\ (x)$) as long as final answer is correct
				[3]		
5	(ii)		$(3\cos x - 2)(2\cos x + 1) = 0$ $\cos x = {}^{2}/_{3}$, $\cos x = {}^{-1}/_{2}$ $x = 48.2^{\circ}, 312^{\circ}, 120^{\circ}, 240^{\circ}$	M1	Attempt to solve quadratic in $\cos x$	This M mark is just for solving a 3 term quadratic (see guidance sheet for acceptable methods) Condone any substitution used, including $x = \cos x$
				M1	Attempt to find x from root(s) of quadratic	Attempt $\cos^{-1}$ of at least one of their roots Allow for just stating $\cos^{-1}$(their root) inc if $\lvert \cos x \rvert > 1$ Not dependent so M0 M1 possible If going straight from $\cos x = k$ to $x = ...$ then award M1 only if their angle is consistent with their k
				A1	Obtain at least 2 correct angles	Allow 3sf or better Must come from correct solution of quadratic - ie correct factorisation or correct substitution into formula so A0 if two correct roots from eg $(3\cos x + 2)(2\cos x + 1) = 0$ Allow radian equivs - 0.841, 5.44, ${}^{2\pi}/_{3}$ or 2.09, ${}^{4\pi}/_{3}$ or 4.19
				A1	Obtain all 4 correct angles, with no extra in given range	Must now be in degrees **SR** If no working shown then allow **B1** for 2 correct angles (poss in rads) or **B2** for 4 correct angles, no extras
				[4]		

Question			Answer	Marks	Guidance	
6	(i)		$(x + 4) - 2x = (2x - 7) - (x + 4)$ **OR** $2x + d = x + 4 \quad 2x + 2d = 2x - 7$	M1	Attempt to eliminate d to obtain equation in x only	Equate two expressions for d, both in terms of x Could use $a + (n - 1)d$ twice, and then eliminate d Could use $u_1 + u_2 + u_3 = S_3$ or $u_2 = ½ (u_1 + u_3)$
				A1	Obtain correct equation in just x	Allow unsimplified equation A0 if brackets missing unless implied by subsequent working or final answer
			$2x = 15$ $x = 7.5$	A1	Obtain $x = 7.5$	Any equivalent form Allow from no working or T&I **Alt method:** B1 - state, or imply, $2x + 2d = 2x - 7$, to obtain $d = -3.5$ M1 - attempt to find x from second equation in x and d A1- obtain $x = 7.5$
				[3]		
6	(ii)	(a)	terms are 16, 12, 9	B1	List 3 terms	Ignore any additional terms given
			$^{12}/_{16} = 0.75$, $^{9}/_{12} = 0.75$ common ratio of 0.75 so GP	B1	Convincing explanation of why it is a GP	Must show two values of 0.75, or unsimplified fractions Must state, or imply, that ratio has been checked twice, using both pairs of consecutive terms No need to show actual division of terms to justify 0.75, so allow eg arrows from one term to the next with 'x0.75' **SR B2** if 16, 12, 9 never stated explicitly in a list but are soi in a convincing method for $r = 0.75$ twice
			$S_\infty = {}^{16}/_{1-0.75}$	M1	Attempt use of $^{a}/_{1-r}$	Must be correct formula Could be implied by method Allow if used with their incorrect a and/or r Allow if using $a = 8$, even if 16 given correctly in list
			$= 64$	A1	Obtain 64	A0 if given as 'approximately 64'
				[4]		

Question			Answer	Marks	Guidance	
6	(ii)	(b)	${}^{(2x-7)}/_{(x+4)} = {}^{(x+4)}/_{2x}$ $4x^2 - 14x = x^2 + 8x + 16$ **OR** $2xr = x + 4 \quad 2xr^2 = 2x - 7$ $3x^2 - 22x - 16 = 0$ $(3x + 2)(x - 8) = 0$ $x = {}^{-2}/_3,\ x = 8$	M1*	Attempt to eliminate r to obtain equation in x only	Equate two expressions for r, both in terms of x Could use ar^{n-1} twice, and then eliminate r from simultaneous eqns
				A1	Obtain $3x^2 - 22x - 16 = 0$	Allow $6x^2 - 44x - 32 = 0$ Allow $3x^3 - 22x^2 - 16x = 0$, or a multiple of this Allow any equivalent form, as long as no brackets and like terms have been combined Condone no = 0, as long as implied by subsequent work
				M1d*	Attempt to solve quadratic	Dependent on first M1 for valid method to eliminate r See guidance sheet for acceptable methods
				A1	Obtain $x = {}^{-2}/_3$	Allow recurring decimal, but not rounded or truncated Condone $x = 8$ also given Allow from no working or T&I
				[4]		
7	(i)		$\cos^{-1} {}^6/_7 = 0.5411$ **AG**	M1	Attempt correct method to find angle CAB	Either use cosine rule or right-angled trigonometry Allow M1 for $\cos A = {}^6/_7$ or equiv from cosine rule If first finding another angle, they must get as far as attempting angle CAB for the M1 Allow in degrees or radians
				A1	Obtain 0.5411	Must be given to exactly 4sf, as per question If angle found as 31° then conversion to radians must be shown explicitly
				[2]		

Question			Answer	Marks	Guidance	
7	(ii)		arc length = 7 x (2 x 0.5411) = 7.575 perimeter = 15.2	M1	Attempt arc length using 7θ	Must be using $r = 7$ Allow if using $\theta = 0.5411$ not 1.0822 If no method shown then award M1 for value seen in the range [7.56, 7.58] M0 if using angle other than 0.5411 or 1.0822 (inc M0 for 1.0822π) but allow M1 if required angle is intended eg 0.54 or a slip when doubling 0.5411 Allow valid method with degrees, but M0 for 7θ with θ in degrees Allow equivalent method using fractions of the circle
				A1 **[2]**	Obtain perimeter as 15.2, or better	Allow 15.15, or anything that rounds to this with no errors seen

Question			Answer	Marks	Guidance	
7	(iii)		sector area = ½ x 7^2 x (2 x 0.5411) = 26.51 triangle area = ½ x 7^2 x sin 1.082 = 21.63 area of segment = 4.88 shaded area = 9.76 cm^2	M1*	Attempt area of one sector using (½) x 7^2 x θ, or equiv	Allow if using θ = 0.5411 not 1.0822 Allow M1 if 13.3 or 26.5 seen with no method M0 if using angle other than 0.5411 or 1.0822 (inc M0 for 1.0822π) unless clearly intended as correct angle Allow equivalent method using fractions of the circle Allow valid method with degrees, but M0 for (½)$r^2\theta$ with θ in degrees Condone omission of ½, but no other error May be seen explicitly or implied in method eg as part of ½$r^2(\theta$ - sin $\theta)$
				M1*	Attempt area of relevant triangle or area of rhombus	Condone omission of ½ from ½absinθ Allow if using θ = 0.5411 not 1.0822 in (½) x 7^2 x sinθ Allow if attempting area of triangle ABC Could be using radians or degrees Allow even if evaluated in incorrect mode If using a right-angled triangle, it must be ½bh, and valid use of trig to find b or h
				A1	Obtain 4.88, or better, either as final answer or soi in method	Could come from finding area of segment but omitting to double it Allow inaccuracy - values in range [4.85, 4.9] Allow even if value not seen explicitly – could be implied by part of a calculation or even by final answer
				M1d*	Attempt correct method to find required area	Must be full and valid method – including attempted use of correct angle and subtraction in correct order Could find area of one segment and double it Other methods are possible eg 2 x sector minus rhombus
				A1	Obtain 9.76, or better	Allow answer rounding to 9.76, no errors seen
				[5]		

Question			Answer	Marks	Guidance	
8	(i)		Translation of 3 units in positive *x*-direction	B1	State translation	Must be 'translation' and not 'move', slide', 'shift' etc
				B1	State or imply 3 units in positive *x*-direction	Independent of first B1 Allow vector notation, but not a coordinate ie (3, 0) Worded descriptions must give clear intention of direction, so B0 for just '*x*-direction' or 'parallel to *x*-axis' unless +3 also stated (as '+' implies the direction) For the direction, allow 'in the positive *x*-direction', 'parallel to the positive *x*-axis' or 'to the right' Do not allow 'in the positive *x*-axis' or 'along the positive *x*-axis' even if combined with correct statement eg 'right' Allow '3' or '3 units' but not '3 places', '3 squares', 'sf 3'... Ignore irrelevant statements (eg intercepts on axes), but penalise contradictions **B0 B0** if second transformation also given
				[2]		

Question			Answer	Marks	Guidance	
8	(ii)		$a = 8$	B1 **[1]**	State 8	Allow x not a Allow implied value eg (8, 3) or $\log_2 8 = 3$
8	(iii)		$b - 3 = 2^{1.8}$ $b = 6.48$	B1 B1 **[2]**	State or imply $b - 3 = 2^{1.8}$ Obtain 6.48, or better	Allow x not b More accurate answer is 6.482202253... Answer only can gain B2 as long as accurate
8	(iv)		$\log_2 c - \log_2(c - 3) = 4$ $\log_2 {}^{c}/_{c-3} = 4$ ${}^{c}/_{c-3} = 2^4$ $c = 16c - 48$ $c = {}^{48}/_{15} = {}^{16}/_{5}$	M1	Equate difference in y-coordinates to ± 4	Allow in terms of x not c Allow any equiv eg $\log_2 c = \log_2(c - 3) + 4$ Brackets must be seen, or implied by later working Allow if subtraction is the other way around, but M0 if two log terms are summed Allow as part of an attempt at Pythagoras' theorem eg $\sqrt{\{(c - c)^2 + (\log_2 c - \log_2(c - 3))^2\}} = 4$
				M1	Use $\log a - \log b = \log {}^{a}/_{b}$	Could be implied if $\log_2$ dealt with at the same time Must be used on difference not sum if using the two algebraic terms ie $\pm (\log_2 c - \log_2(c - 3))$ Starting with $\log_2 c = \log_2 (c - 3)$, rearranging to equal 0 and then using a log law could get M1 Allow if 4 is attempted as $\log_2 k$ ($k \neq 4$) and then combined with at least one of the other two terms (possibly using $\log a + \log b$) Allow if attempted with their now incorrect 4 Allow if they started with a constant other than ± 4 ie attempting to rewrite k as $\log_2 2^k$ and then combining with at least one of the algebraic logs gets M1
				A1	Obtain ${}^{c}/_{c-3} = 2^4$	Any correct equation, in a form not involving logs
				A1 **[4]**	Obtain ${}^{16}/_{5}$ oe	Allow 3.2, or unsimplified fraction **SR B2** for answer only or T&I

Question			Answer	Marks	Guidance	
9	(i)		$\int(2x - 5 + 4x^{-2})\,dx = x^2 - 5x - 4x^{-1}$ $(4a^2 - 10a - {}^2/_a) - (a^2 - 5a - {}^4/_a)$ $= 0$ $3a^2 - 5a + {}^2/_a = 0$ $3a^3 - 5a^2 + 2 = 0$ **AG**	M1	Attempt to rewrite integrand in a suitable form	Attempt to divide all 3 terms by x^2, or attempt to multiply all 3 terms by x^{-2} soi
				A1	Obtain $2x - 5 + 4x^{-2}$	Allow if third term is written in fractional form
				M1	Attempt integration of their integrand	Their integrand must be written as a polynomial ie with all terms of the form kx^n, and no brackets At least two terms must increase in power by 1 Allow if the – 5 disappears
				A1	Obtain $x^2 - 5x - 4x^{-1}$	Allow unsimplified (eg ${}^4/_{-1}\,x^{-1}$)
				M1	Attempt use of limits	Must be F(2a) - F(a) ie subtraction with limits in the correct order Allow if no brackets ie $4a^2 - 10a - {}^2/_a - a^2 - 5a - {}^4/_a$ Must be in integration attempt, but allow M1 for limits following M0 for integration eg if fraction not dealt with before integrating
				A1	Equate to 0 and rearrange to obtain $3a^3 - 5a^2 + 2 = 0$	Must be equated to 0 before multiplying through by a At least one extra line of working required between $(4a^2 - 10a - {}^2/_a) - (a^2 - 5a - {}^4/_a) = 0$ and the final answer **AG** so look carefully at working
				[6]		

Question			Answer	Marks	Guidance	
9	(ii)		$f(1) = 3 - 5 + 2 = 0$ **AG**			**Allow working in *x* not *a* throughout**
			$f(a) = (a-1)(3a^2 - 2a - 2)$	B1	Confirm f(1) = 0 – detail required	$3(1)^3 - 5(1)^2 + 2 = 0$ is enough B0 for just f(1) = 0 If using division must show '0' on last line If using coefficient matching must show 'R = 0' If using inspection then there must be some indication of no remainder eg expand to show correct cubic
			$a = \frac{2 \pm \sqrt{4+24}}{6} = \frac{2 \pm 2\sqrt{7}}{6} = \frac{1 \pm \sqrt{7}}{3}$	M1	Attempt full division by $(a - 1)$, or equiv method	Must be complete method - ie all 3 terms attempted Long division - must subtract lower line (allow one slip) Inspection - expansion must give at least three correct terms of the cubic Coefficient matching - must be valid attempt at all coeffs of quadratic, considering all relevant terms each time
			hence $a = \frac{1}{3}(1 + \sqrt{7})$	A1	Obtain $3a^2$ and one other correct term	Could be middle or final term depending on method Must be correctly obtained Coeff matching - allow for $A = 3$ etc
				A1	Obtain fully correct quotient	Could appear as quotient in long division, or as part of a product if using inspection. For coeff matching it must now be explicit not just $A = 3$, $B = -2$, $C = -2$
				M1	Attempt to solve quadratic	Using the quadratic formula, or completing the square (see guidance sheet) though negative root may be lost at any point M0 if factorising attempt as expected root is a surd Quadratic must come from division attempt, even if this was not good enough for first M1
				A1 **[6]**	Obtain $\frac{1}{3}(1 + \sqrt{7})$ only	Must give the positive root only, so A0 if negative root still present (but condone $a = 1$ also given) Allow aef but must be a simplified surd as per request on question paper (ie simplify $\sqrt{28}$)