OCR
RECOGNISING ACHIEVEMENT

Friday 17 May 2013 – Morning

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.

INSTRUCTION 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 Use the trapezium rule, with 3 strips each of width 2, to estimate the value of

$$\int_5^{11} \frac{8}{x}\,dx.$$ **[4]**

2 Solve each of the following equations, for $0° \leqslant x \leqslant 360°$.

(i) $\sin \frac{1}{2}x = 0.8$ **[3]**

(ii) $\sin x = 3\cos x$ **[3]**

3 **(i)** Find and simplify the first three terms in the expansion of $(2 + 5x)^6$ in ascending powers of x. **[4]**

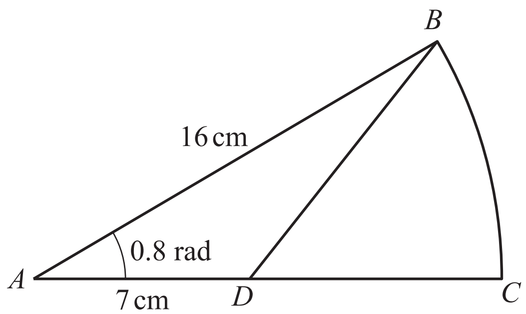
(ii) In the expansion of $(3 + cx)^2(2 + 5x)^6$, the coefficient of x is 4416. Find the value of c. **[3]**

4 **(a)** Find $\int (5x^3 - 6x + 1)\,dx$. **[3]**

(b) **(i)** Find $\int 24x^{-3}\,dx$. **[2]**

(ii) Given that $\int_a^{\infty} 24x^{-3}\,dx = 3$, find the value of the positive constant a. **[3]**

5



The diagram shows a sector BAC of a circle with centre A and radius 16 cm. The angle BAC is 0.8 radians. The length AD is 7 cm.

(i) Find the area of the region BDC. **[4]**

(ii) Find the perimeter of the region BDC. **[4]**

6 Sarah is carrying out a series of experiments which involve using increasing amounts of a chemical. In the first experiment she uses 6 g of the chemical and in the second experiment she uses 7.8 g of the chemical.

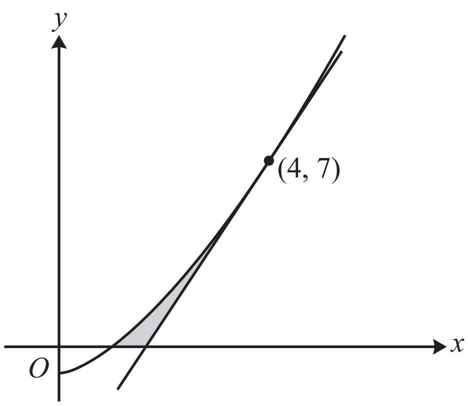
(i) Given that the amounts of the chemical used form an arithmetic progression, find the total amount of chemical used in the first 30 experiments. **[3]**

(ii) Instead it is given that the amounts of the chemical used form a geometric progression. Sarah has a total of 1800 g of the chemical available. Show that N, the greatest number of experiments possible, satisfies the inequality

$$1.3^N \leqslant 91,$$

and use logarithms to calculate the value of N. **[6]**

7

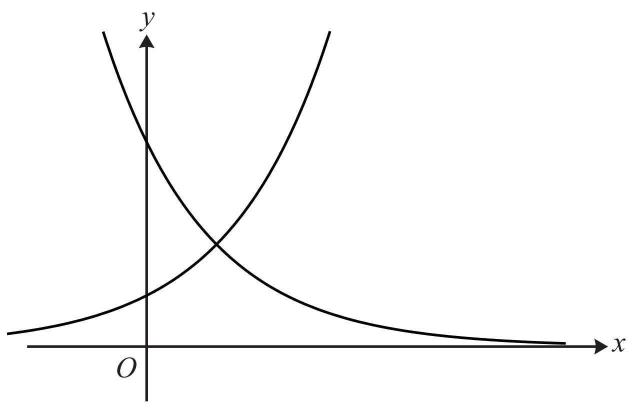


The diagram shows the curve $y = x^{\frac{3}{2}} - 1$, which crosses the x-axis at (1, 0), and the tangent to the curve at the point (4, 7).

(i) Show that $\int_1^4 (x^{\frac{3}{2}} - 1)\,dx = 9\frac{2}{5}$. **[4]**

(ii) Hence find the exact area of the shaded region enclosed by the curve, the tangent and the x-axis. **[5]**

8



The diagram shows the curves $y = a^x$ and $y = 4b^x$.

(i) **(a)** State the coordinates of the point of intersection of $y = a^x$ with the y-axis. **[1]**

(b) State the coordinates of the point of intersection of $y = 4b^x$ with the y-axis. **[1]**

(c) State a possible value for a and a possible value for b. **[2]**

(ii) It is now given that $ab = 2$. Show that the x-coordinate of the point of intersection of $y = a^x$ and $y = 4b^x$ can be written as

$$x = \frac{2}{2\log_2 a - 1}.$$

[5]

9 The cubic polynomial $f(x)$ is defined by $f(x) = 4x^3 - 7x - 3$.

(i) Find the remainder when $f(x)$ is divided by $(x - 2)$. **[2]**

(ii) Show that $(2x + 1)$ is a factor of $f(x)$ and hence factorise $f(x)$ completely. **[6]**

(iii) Solve the equation

$$4\cos^3\theta - 7\cos\theta - 3 = 0$$

for $0 \leqslant \theta \leqslant 2\pi$. Give each solution for θ in an exact form. **[4]**

RECOGNISING ACHIEVEMENT

Question			Answer	Marks	Guidance	
1			$\frac{1}{2} \times 2 \times ({}^{8}/_{5} + 2({}^{8}/_{7} + {}^{8}/_{9}) + {}^{8}/_{11})$	M1	Attempt the 4 correct y-coordinates, and no others	M0 if other y-values also found (unless not used) Allow decimal equivs
				M1	Attempt correct trapezium rule, any h, to find area between $x = 5$ and $x = 11$	Correct structure required, including placing of y-values The 'big brackets' must be seen, or implied by later working - this may not be clear if using $h = 2$ so allow BOD for eg $\frac{1}{2} \times 2 \times ({}^{8}/_{5} + {}^{8}/_{11}) + 2({}^{8}/_{7} + {}^{8}/_{9})$ Could be implied by stating general rule in terms of y_0 etc, as long as these have been attempted elsewhere and clearly labelled Could use other than 3 strips as long as of equal width Using x-values is M0 Can give M1, even if error in evaluating y-values as long correct intention is clear Allow BoD if first or last y-value incorrect, unless clearly from an incorrect x-value
				M1	Use correct h (soi) for their y-values (must have equally spaced x-values), to find area between $x = 5$ and $x = 11$	Must be in attempt at trap rule, not Simpson's rule As $h = 2$, allow BOD if ${}^{1}/_{2} \times 2$ not seen explicitly Allow if muddle over placing y-values, including duplication, (but M0 for x-values) Allow if ½ missing Allow other than 3 strips, as long as h is consistent
			= 6.39	A1	Obtain 6.39, or better	Allow answers in the range [6.390, 6.391] if >3sf Answer only is 0/4 Using 2 strips of width 3 is M0M1M1 and not a misread Using the trap rule on result of an integration attempt is 0/4 – this includes functions such as $8x$ even if integration is not explicit Using 3 separate trapezia can get full marks – if other than 3 trapezia then mark as above However, using only one trapezium is 0/4
				[4]		

Question			Answer	Marks	Guidance	
2	(i)		$\frac{1}{2}x = 53.1°, 126.9°$	B1	Obtain 106°, or better	Allow answers in the range [106.2, 106.3] Ignore any other solutions for this mark Must be in degrees, so 1.85 rad is B0
			$x = 106°, 254°$	M1	Attempt correct solution method to find second angle	Could be 2(180° – their 53.1°) or (360° – their 106°) Allow valid method in radians, but M0 for eg (360 – 1.85)
				A1	Obtain 254°, or better	Allow answers in the range [253.7°, 254°] A0 if in radians (4.43) A0 if extra incorrect solutions in range **SR** If no working shown then allow B1 for 106° and B2 for 254° (max B2 if additional incorrect angles)
				[3]		
2	(ii)		$\tan x = 3$	B1	State $\tan x = 3$	Allow B1 for correct equation even if no, or an incorrect, attempt to solve Give BOD on notation eg $^{\sin}/_{\cos}(x)$ as long as correct equation is seen or implied at some stage
			$x = 71.6°, 252°$	M1	Attempt to solve $\tan x = k$	Not dep on B1, so could gain M1 for solving eg $\tan x = {}^{1}/_{3}$ Could be implied by a correct solution
				A1	Obtain 71.6° and 252°, or better	A0 if extra incorrect solutions in range **Alt method:** **B1** Obtain $10\sin^2 x = 9$ or $10\cos^2 x = 1$ **M1** Attempt to solve $\sin^2 x = k$ or $\cos^2 x = k$ (allow M1 if just the positive square root used) **A1** Obtain 71.6° and 252°, with no extra incorrect solutions in range **SR** If no working shown at all then allow B1 for each correct angle (max B1 if additional incorrect angles), but allow full credit if $\tan x = 3$ seen first
				[3]		

Question			Answer	Marks	Guidance	
3	(i)		$(2 + 5x)^6 = 64 + 960x + 6000x^2$	M1	Attempt at least first 2 terms– products of binomial coeff and correct powers of 2 and $5x$	Must be clear intention to use correct powers of 2 and $5x$ Binomial coeff must be 6 soi; ${}^6C_1$ is not yet enough Allow BOD if 6 results from ${}^6/_1$ Allow M1 if expanding $k(1 + {}^5/_2\, x)^6$, any k
				A1	Obtain $64 + 960x$	Allow 2^6 for 64 Allow if terms given as list rather than linked by '+'
				M1	Attempt 3rd term – product of binomial coeff and correct powers of 2 and $5x$	Allow M1 for $5x^2$ rather than $(5x)^2$ Binomial coeff must be 15 soi; ${}^6C_2$ is not yet enough Allow M1 if expanding $k(1 + {}^5/_2\, x)^6$, any k $1200x^2$ implies M1, as long as no errors seen (including no working shown)
				A1 **[4]**	Obtain $6000x^2$	A0 if an otherwise correct expansion is subsequently spoiled by attempt to simplify eg $4 + 60x + 375x^2$ **If expanding brackets:** Mark as above, but must consider all 6 brackets for the M marks (allow irrelevant terms to be discarded)
3	(ii)		$(9 + 6cx \ldots)(64 + 960x + \ldots)$	M1*	Expand first bracket and attempt at least one relevant product	Expansion of first bracket does not have to be correct, but must be attempted so M0 if using $(3 + cx)(64 + 960x\ldots)$ No need to see third term in expansion of first bracket Must then consider a product and not just use $6c + 960$ Expansion could include irrelevant / incorrect terms Using an incorrect expansion associated with part **(i)** can get M1 M1
			$(9 \times 960) + (6c \times 64) = 4416$ $8640 + 384c = 4416$ $384c = -4224$	M1d*	Equate sum of the two relevant terms to 4416 and attempt to solve for c	Must now consider just the two relevant terms M0 if additional terms, even if error has resulted in kx BOD if presence of x is inconsistent within equation
			$c = -11$	A1 **[3]**	Obtain $c = -11$	A0 for $c = -11x$

Question			Answer	Marks	Guidance	
4	(a)		${}^{5}/_{4}x^4 - 3x^2 + x + c$	M1	Attempt integration	Increase in power by 1 for at least two of the three terms Allow M1 if the +1 disappears
				A1	Obtain at least 2 correct (algebraic) terms	Integral must be of form $ax^4 + bx^2 + cx$ Allow for unsimplified ${}^{6}/_{2}\, x^2$ and/or $1x$
				A1	Obtain a fully correct integral, including $+ c$	Coeff of x^2 must now be simplified, as well as x not $1x$ A0 if integral sign or dx still present in final answer Ignore notation on LHS such as $\int = ...$, $y = ...$, ${}^{dy}/_{dx} = ...$
				[3]		
4	(b)	(i)	$-12x^{-2} + c$	M1	Obtain integral of form kx^{-2}	Any k, including unsimplified
				A1	Obtain fully correct integral, including $+ c$	Coeff must now be simplified A0 if integral sign or dx still present in final answer Do not penalise again if already penalised in part **(a)**, even if different error including omission of $+ c$ Ignore notation on LHS such as $\int = ...$, $y = ...$, ${}^{dy}/_{dx} = ...$
				[2]		
4	(b)	(ii)	$(0) - (-12a^{-2}) = 3$	M1*	Attempt F(∞) – F(a) and use or imply that F(∞) = 0	Must be subtraction and correct order Could use a symbol for the upper limit, eg s, and then consider $s \to \infty$ $0 - 12a^{-2}$, with no other supporting method, is M0 as this implies addition Allow BOD for $-12 \times (0)^{-2}$ as long as it then becomes 0 Allow M1 for using incorrect integral from **(b)(i)** as long as it is of the form kx^{-n} with $n \neq 3$
			$a^2 = 4$	M1d*	Equate to 3 and attempt to find a	Dependent on first M1 soi Allow muddle with fractions eg $a^2 = {}^{1}/_{4}$
			$a = 2$	A1	Obtain $a = 2$ only	A0 if –2 still present as well
				[3]		Answer only is 0/3 **NB** watch for $a = 2$ as a result of solving $24a^{-3} = 3$, which gets no credit

Question			Answer	Marks	Guidance	
5	(i)		sector area = $\frac{1}{2} \times 16^2 \times 0.8$ = 102.4	M1*	Attempt area of sector using $(\frac{1}{2})\ r^2\theta$, or equiv	Condone omission of ½, but no other errors Must have $r = 16$, not 7 M0 if 0.8π used not 0.8 M0 if $(\frac{1}{2})\ r^2\theta$ used with θ in degrees Allow equiv method using fractions of a circle
			triangle area = $\frac{1}{2} \times 16 \times 7 \times \sin 0.8$ = 40.2	M1*	Attempt area of triangle using $(\frac{1}{2})\ ab\sin C$ or equiv	Condone omission of ½, but no other errors Angle could be in radians (0.8 not 0.8π) or degrees (45.8°) Must have sides of 16 and 7 Allow even if evaluated in incorrect mode (gives 0.78) If using $\frac{1}{2} \times b \times h$, then must be valid use of trig to find b and h
				M1d*	Attempt area of sector – area of triangle	Using $\frac{1}{2} \times 16^2 \times (0.8 - \sin 0.8)$ will get M1 M0 M0
			area BDC = 62.2 cm^2	A1 **[4]**	Obtain 62.2, or better	Allow answers in range [62.20, 62.25] if > 3sf
5	(ii)		$BD^2 = (16^2 + 7^2 - 2\times16\times7\times\cos 0.8)$ BD = 12.2	M1	Attempt length of BD using correct cosine rule	Must be correct cosine rule Allow M1 if not square rooted, as long as BD^2 seen M0 if 0.8π used not 0.8 Allow if evaluated in degree mode (gives 9.00) Allow if incorrectly evaluated - using $(16^2 + 7^2 - 2 \times 16 \times 7) \times \cos 0.8$ gives 7.51 Allow any equiv method, as long as valid use of trig Attempting the cosine rule in part **(i)** will only get credit if result appears in part **(ii)**
				A1	Obtain 12.2, or better	Allow any answer rounding to 12.2, with no errors seen Could be implied in method rather than explicit
			arc $BC = 16 \times 0.8 = 12.8$	B1	State or imply that arc BC is 12.8	Allow if 16×0.8 seen, even if incorrectly evaluated
			per = 12.2 + 12.8 + 9 = 34.0 cm	A1 **[4]**	Obtain 34, or better	Accept 34 or 34.0, or any answer rounding to 34.0 if >3sf

Question			Answer	Marks	Guidance	
6	(i)		$S_{30} = {}^{30}/_2\ (2 \times 6 + 29 \times 1.8)$	M1	Use $d = 1.8$ in AP formula	Could be attempting S_{30} or u_{30} Formula must be recognisable, though not necessarily fully correct, so allow M1 for eg $15(6 + 29 \times 1.8)$, $15(12 + 14 \times 1.8)$ or even $15(12 + 19 \times 1.8)$ Must have $d = 1.8$ (not 1.3), $n = 30$ and $a = 6$
				A1	Correct unsimplified S_{30}	Formula must now be fully correct Allow for any unsimplified correct expression If using $^1/_2 n(a + l)$ then l must be correct when substituted
			$= 963$	A1 **[3]**	Obtain 963	Units not required
6	(ii)		$r = {}^{7.8}/_6 = 1.3$	M1	Use $r = 1.3$ in GP formula	Could be attempting S_N , u_N or even S_∞ Formula must be recognisable, though not necessarily fully correct Must have $r = 1.3$ (not 1.8) and $a = 6$
			$\frac{6(1-1.3^N)}{1-1.3} \le 1800$	A1	Correct unsimplified S_N	Formula must now be fully correct Allow for any unsimplified correct expression
			$1 - 1.3^N \ge -90$	M1	Link sum of GP to 1800 and attempt to rearrange to $1.3^N \le k$	Must have used correct formula for S_N of GP Allow =, ≥ or ≤ Allow slips when rearranging, including with indices, so rearranging to $7.8^N \le k$ could get M1
			$1.3^N \le 91$ **AG**	A1	Obtain given inequality	Must have correct inequality signs throughout Correct working only, so A0 if 6×1.3^N becomes 7.8^N, even if subsequently corrected

Question			Answer	Marks	Guidance	
			$N \log 1.3 \leq \log 91$	M1	Introduce logs throughout and attempt to solve equation / inequality	Must be using $1.3^N \leq 91$, $1.3^N = 91$ or $1.3^N \geq 91$ This M1 (and then A1) is independent of previous marks Must get as far as attempting N M0 if no evidence of use of logarithms M0 if invalid use of logarithms in attempt to solve
			$N \leq 17.19$ hence $N = 17$	A1	Conclude $N = 17$	Must come from solving $1.3^N \leq 91$or $1.3^N = 91$ (ie not incorrect inequality sign) Answer must be integer value Answer must be equality, so A0 for $N \leq 17$ **SR** Candidates who use numerical value(s) for N can get M1 Use $r = 1.3$ in a recognisable GP formula (M0 if N is not an integer value) A1 Obtain a correct unsimplified S_N Candidates who solve $1.3^N \leq 91$ and then use a value associated with their N (usually 17 and/or 18) in a GP formula will be eligible for the M1A1 for solving the inequality and also the M1A1 in the **SR** above
				[6]		

Question			Answer	Marks	Guidance	
7	(i)		$\int_1^4 \left(x^{\frac{3}{2}} - 1\right) dx = \left[\frac{2}{5}x^{\frac{5}{2}} - x\right]_1^4$	M1	Attempt integration	Increase in power by 1 for at least one term - allow the –1 to disappear
				A1	Obtain fully correct integral	Coeff could be unsimplified eg $^1/_{2.5}$ Could have + c present
			= (12.8 – 4) – (0.4 – 1)	M1	Attempt correct use of limits	Must be explicitly attempting F(4) – F(1), either by clear substitution of 4 and 1 or by showing at least (8.8) – (–0.6) Allow M1 if + c still present in both F(4) and F(1), but M0 if their c is now numerical Allow use in any function other than the original
			= $9^2/_5$ **AG**	A1 **[4]**	Obtain $9^2/_5$	**AG**, so check method carefully Allow $^{47}/_5$ or 9.4
7	(ii)		$m = {^3/_2} \times \sqrt{4} = 3$	M1*	Attempt to find gradient at (4, 7) using differentiation	Must be reasonable attempt at differentiation ie decrease the power by 1 Need to actually evaluate derivative at $x = 4$
			$y = 3x - 5$	M1d*	Attempt to find point of intersection of tangent with x-axis or attempt to find base of triangle	Could attempt equation of tangent and use $y = 0$ Could use equiv method with gradient eg $3 = {^7/_{4-x}}$ Could just find base of triangle using gradient eg $3 = {^7/_b}$
			tangent crosses x-axis at $(^5/_3, 0)$	A1	Obtain $x = {^5/_3}$ as pt of intersection or obtain $^7/_3$ as base of triangle	Allow decimal equiv, such as 1.7, 1.67 or even 1.6 www Allow M1M1A1 for $x = {^5/_3}$ with no method shown
			area of triangle = $^1/_2 \times (4 - {^5/_3}) \times 7$ = $8^1/_6$	M1d**	Attempt complete method to find shaded area	Dependent on both previous M marks Find area of triangle and subtract from $9^2/_5$ Must have 1 < their x < 4, and area of triangle < $9^2/_5$ If using $\int(3x - 5)dx$ then limits must be 4 and their x M1 for area of trapezium – area between curve and y-axis
			shaded area = $9^2/_5 - 8^1/_6 = 1^7/_{30}$	A1 **[5]**	Obtain $1^7/_{30}$, or exact equiv	A0 for decimal answer (1.23), unless clearly a recurring decimal (but not eg 1.2333...)

Question			Answer	Marks	Guidance	
8	**(i)**	**(a)**	(0, 1)	B1 **[1]**	State (0, 1)	Allow no brackets B1 for $x = 0$, $y = 1$ – must have $x = 0$ stated explicitly B0 for $y = a^0 = 1$ (as $x = 0$ is implicit)
		(b)	(0, 4)	B1 **[1]**	State (0, 4)	Allow no brackets B1 for $x = 0$, $y = 4$ – must have $x = 0$ stated explicitly B0 for $y = 4b^0 = 4$ (as $x = 0$ is implicit)
		(c)	State a possible value for a	B1	Must satisfy $a > 1$	Must be a single value Could be irrational eg e Must be fully correct so B0 for eg 'any positive number such as 3'
			State a possible value for b	B1 **[2]**	Must satisfy $0 < b < 1$	Must be a single value Could be irrational eg e^{-1} Must be fully correct **SR** allow B1 if both a and b given correctly as a range of values

Question			Answer	Marks	Guidance	
8	(ii)		$\log_2 a^x = \log_2(4b^x)$	M1	Equate a^x and $4b^x$ and introduce logarithms at some stage	Could either use the two given equations, or b could have already been eliminated so using two eqns in a only Must take logs of each side soi so M0 for $4\log_2(b^x)$ Allow just log, with no base specified, or $\log_2$ Allow logs to any base, or no base, as long as consistent
			$\log_2 a^x = \log_2 4 + \log_2 b^x$	M1	Use $\log ab = \log a + \log b$ correctly	Or correct use of $\log {}^a/_b = \log a - \log b$ Used on a correct expression eg $\log_2(4b^x)$ or $\log_2 4(^2/_a)^x$ Equation could either have both a and b or just a Must be used on an expression associated with $a^x = 4b^x$, either before or after substitution, so M0 for $\log_2(ab) = 1$ hence $\log_2 a + \log_2 b = 1$ Could be an equiv method with indices before using logs eg $a^{2x} = 4 \times 2^x$ hence $a^{2x} = 2^{2+x}$
			$x\log_2 a = \log_2 4 + x\log_2 b$	M1	Use $\log a^b = b \log a$ correctly at least once	Allow if used on an expression that is possibly incorrect Allow M1 for $x\log_2 a = x\log_2 4b$ as one use is correct Equation could either have both a and b or just a
			$x\log_2 a = \log_2 4 + x\log_2(^2/_a)$	B1	Use $b = {}^2/_a$ to produce a correct equation in a and x only	Can be gained at any stage, including before use of logs If logs involved then allow for no, or incorrect, base as long as equation is fully correct – ie if $\log 2^k = k$ used then base must be 2 throughout equation Could be an equiv method eg $(a \times a)^x = 4(a \times b)^x$ hence $a^{2x} = 4 \times 2^x$ Must be eliminating b, so $(^2/_b)^x = 4b^x$ is B0 unless the equation is later changed to being in terms of a
			$x\log_2 a = 2 + x\log_2 2 - x\log_2 a$ $x(2\log_2 a - 1) = 2$ $x = \dfrac{2}{2\log_2 a - 1}$ **AG**	A1 **[5]**	Obtain given relationship with no wrong working	Proof must be fully correct with enough detail to be convincing Must use $\log_2$ throughout proof for A1 – allow 1 slip Using numerical values for a and b will gain no credit Working with equation(s) involving y is M0 unless y is subsequently eliminated

Question			Answer	Marks	Guidance	
9	(i)		$f(2) = 32 - 14 - 3 = 15$	M1	Attempt f(2) or equiv	M0 for using $x = -2$ (even if stated to be f(2)) At least one of the first two terms must be of the correct sign Must be evaluated and not just substituted Allow any other valid method as long as remainder is attempted (see guidance in part **(ii)** for acceptable methods)
				A1	Obtain 15	Do not ISW if subsequently given as –15 If using division, just seeing 15 on bottom line is fine unless subsequently contradicted by eg –15 or ${}^{15}/_{x-2}$
				[2]		
9	(ii)		$f(^{-1}/_2) = {}^{-1}/_2 + {}^7/_2 - 3 = 0$ **AG**	B1	Confirm $f(^{-1}/_2) = 0$, with at least one line of working	$4(^{-1}/_2)^3 - 7(^{-1}/_2) - 3 = 0$ is enough B0 for just $f(^{-1}/_2) = 0$ If, and only if, $f(^{-1}/_2)$ is **not** attempted then allow B1 for other evidence such as division / coeff matching etc If using division must show '0' on last line or make equiv comment such as 'no remainder' If using coefficient matching must show 'R = 0' Just writing $f(x)$ as the product of the three correct factors is not enough evidence on its own for B1
			$f(x) = (2x + 1)(2x^2 - x - 3)$	M1	Attempt complete division by $(2x + 1)$, or another correct factor	Could divide by $(x + 1)$, $(x + {}^1/_2)$, $(2x - 3)$, $(x - {}^3/_2)$ 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

Question			Answer	Marks	Guidance	
			$= (2x + 1)(2x - 3)(x + 1)$	A1	Obtain $2x^2$ and one other correct term	Could be middle or final term depending on method Must be correctly obtained Coeff matching - allow for $A = 2$ etc Or lead term and one another correct for their factor
				A1	Obtain fully correct quotient of $2x^2 - x - 3$	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 $A = 2$, $B = -1$, $C = -3$ Or fully correct quotient for their factor
				M1	Attempt to factorise their quadratic quotient from division attempt by correct factor	Allow M1 if brackets would give two correct terms on expansion **SR** allow even if their quadratic does not have rational roots If solving quadratic (eg using the formula) then must attempt factors for M1, but allow eg $(x - {}^3/_2)(x + 1)$
				A1	Obtain $(2x + 1)(2x - 3)(x + 1)$	Final answer must be seen as a product of all three factors Allow factorised equiv such as $2(2x + 1)(x - {}^3/_2)(x + 1)$ but A0 for $(2x + 1)(x - {}^3/_2)(2x + 2)$ as not fully factorised isw if subsequent confusion over 'roots' and 'factors' **SR** If repeated use of factor theorem, or answer given with no working, then allow a possible B1for $f({}^{-1}/_2) = 0$ with an additional **B5** for $(2x + 1)(2x - 3)(x + 1)$, or **B3** for a multiple such as $(2x + 1)(x - {}^3/_2)(x + 1)$
				[6]		

Question			Answer	Marks	Guidance	
9	(iii)		$2\cos\theta + 1 = 0$ $\cos\theta + 1 = 0$ $2\cos\theta - 3 = 0$	M1*	Identify relationship between factors of f(cos θ) and factors of f(x)	Replace x with cos θ in at least one of their factors (could be implied by later working, inc their solutions)
			$\cos\theta = {}^{-1}/_{2}$ $\cos\theta = -1$ $\cos\theta = {}^{3}/_{2}$	M1d*	Attempt to solve cos $\theta = k$ at least once	Must actually attempt θ, with $-1 \le k \le 1$
			$\theta = {}^{2\pi}/_{3}$, ${}^{4\pi}/_{3}$ $\theta = \pi$	A1	Obtain at least 2 correct angles	Allow angles in degrees (120°, 240°, 180°) Allow decimal equivs (2.09, 4.19, 3.14) Allow if $2\cos\theta + 1 = 0$ is the only factor used, or if other incorrect factors are also used Allow M1M1A1 for 2 correct angles with no working shown
				A1 **[4]**	Obtain all 3 correct angles	Must be exact and in radians A0 if additional incorrect angles in range Allow full credit if no working shown Angles must come from 3 correct roots of f(x), but allow if a factor was eg $(x - {}^{3}/_{2})$ not $(2x - 3)$ A0 if incorrect root, even if it doesn't affect the three solutions eg one of their factors was $(2x + 3)$ not $(2x - 3)$