edexcel
advancing learning, changing lives

Mark Scheme (Results)
January 2007

GCE

GCE Mathematics

Core Mathematics C1 (6663)

Edexcel Limited. Registered in England and Wales No. 4496750
Registered Office: One90 High Holborn, London WC1V 7BH

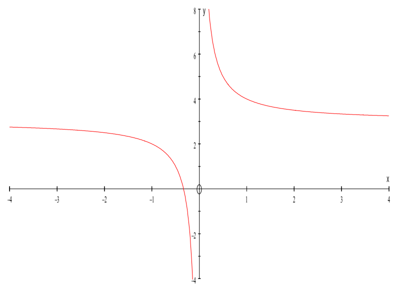
A PEARSON COMPANY

edexcel

January 2007
6663 Core Mathematics C1
Mark Scheme

Question number	Scheme	Marks
1.	$4x^3 \to kx^2$ or $2x^{\frac{1}{2}} \to kx^{-\frac{1}{2}}$ (k a non-zero constant)	M1
	$12x^2, + x^{-\frac{1}{2}}\ldots\ldots,$ $(-1 \to 0)$	A1, A1, B1 (4)
		4
	Accept equivalent alternatives to $x^{-\frac{1}{2}}$, e.g. $\frac{1}{x^{1/2}}$, $\frac{1}{\sqrt{x}}$, $x^{-0.5}$. M1: $4x^3$ 'differentiated' to give kx^2, or… $2x^{\frac{1}{2}}$ 'differentiated' to give $kx^{-\frac{1}{2}}$ (but not for just $-1 \to 0$). 1st A1: $12x^2$ (Do not allow just $3\times 4x^2$) 2nd A1: $x^{-\frac{1}{2}}$ or equivalent. (Do not allow just $\frac{1}{2}\times 2x^{-\frac{1}{2}}$, but allow $1x^{-\frac{1}{2}}$ or $\frac{2}{2}x^{-\frac{1}{2}}$). B1: -1 differentiated to give zero (or 'disappearing'). Can be given provided that at least one of the other terms has been changed. Adding an extra term, e.g. + C, is B0.	

Question number	Scheme	Marks
2.	(a) $6\sqrt{3}$ $\quad (a = 6)$	B1 (1)
	(b) Expanding $(2-\sqrt{3})^2$ to get 3 or 4 separate terms	M1
	$7,\ -4\sqrt{3}$ $\quad (b = 7,\ c = -4)$	A1, A1 (3)
		4
	(a) $\pm 6\sqrt{3}$ also scores B1. (b) M1: The 3 or 4 terms may be wrong. 1st A1 for 7, 2nd A1 for $-4\sqrt{3}$. Correct answer $7-4\sqrt{3}$ with no working scores all 3 marks. $7+4\sqrt{3}$ with or without working scores M1 A1 A0. Other wrong answers with no working score no marks.	

Question number	Scheme		Marks	
3.	(a) 	Shape of $f(x)$	B1	
		Moved up ↑	M1	
		Asymptotes: $y = 3$	B1	
		$x = 0$ (Allow "y-axis")	B1	(4)
		($y \neq 3$ is B0, $x \neq 0$ is B0).		
	(b) $\frac{1}{x} + 3 = 0$	No variations accepted.	M1	
	$x = -\frac{1}{3}$ (or $-0.33\ldots$)	Decimal answer requires at least 2 d.p.	A1	(2)
				6

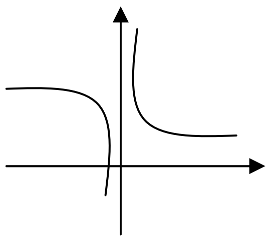
(a) B1: Shape requires both branches and no obvious "overlap" with the asymptotes (see below), but otherwise this mark is awarded generously. The curve may, e.g., bend away from the asymptote a little at the end. Sufficient curve must be seen to suggest the asymptotic behaviour, both horizontal and vertical.

M1: Evidence of an upward translation parallel to the y-axis. The shape of the graph can be wrong, but the complete graph (both branches if they have 2 branches) must be translated upwards. This mark can be awarded generously by implication where the graph drawn is an upward translation of another standard curve (but <u>not</u> a straight line).

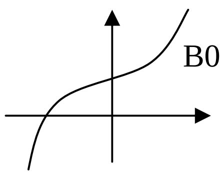
The B marks for asymptote equations are independent of the graph.

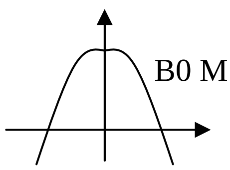
Ignore extra asymptote equations, if seen.

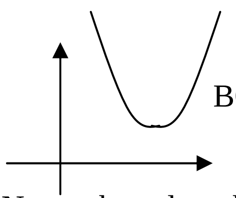
(b) Correct answer with no working scores both marks.
The answer may be seen on the sketch in part (a).
Ignore any attempts to find an intersection with the y-axis.

e.g. 

(a) This scores B0 (<u>clear</u> overlap with horiz. asymp.)
M1 (Upward translation… bod that both branches have been translated).


B0 M1


B0 M1


B0 M0

No marks unless the original curve is seen, to show upward translation.

Question number	Scheme	Marks
4.	$(x-2)^2 = x^2 - 4x + 4$ or $(y+2)^2 = y^2 + 4y + 4$ M: 3 or 4 terms	M1
	$(x-2)^2 + x^2 = 10$ or $y^2 + (y+2)^2 = 10$ M: Substitute	M1
	$2x^2 - 4x - 6 = 0$ or $2y^2 + 4y - 6 = 0$ Correct 3 terms	A1
	$(x-3)(x+1) = 0$, $x = ...$ or $(y+3)(y-1) = 0$, $y = ...$ (The above factorisations may also appear as $(2x-6)(x+1)$ or equivalent).	M1
	$x = 3$ $x = -1$ or $y = -3$ $y = 1$	A1
	$y = 1$ $y = -3$ or $x = -1$ $x = 3$	M1 A1 (7)
	(Allow equivalent fractions such as: $x = \frac{6}{2}$ for x = 3).	**7**
	1st M: 'Squaring a bracket', needs 3 or 4 terms, one of which must be an x^2 or y^2 term. 2nd M: Substituting to get an equation in one variable (awarded generously). 1st A: Accept equivalent forms, e.g. $2x^2 - 4x = 6$. 3rd M: Attempting to solve a 3-term quadratic, to get 2 solutions. 4th M: Attempting at least one *y* value (or *x* value). If *y* solutions are given as *x* values, or vice-versa, penalise at the end, so that it is possible to score M1 M1A1 M1 A1 M0 A0. Strict "pairing of values" at the end is <u>not</u> required. <u>"Non-algebraic" solutions:</u> No working, and only one correct solution pair found (e.g. *x* = 3, *y* = 1): M0 M0 A0 M0 A0 M1 A0 No working, and both correct solution pairs found, but not demonstrated: M0 M0 A0 M1 A1 M1 A1 Both correct solution pairs found, and demonstrated, perhaps in a table of values: Full marks <u>Squaring individual terms:</u> e.g. $y^2 = x^2 + 4$ — M0 $x^2 + 4 + x^2 = 10$ — M1 A0 (Eqn. in one variable) $x = \sqrt{3}$ — M0 A0 (Not solving 3-term quad.) $y^2 = x^2 + 4 = 7$ $y = \sqrt{7}$ — M1 A0 (Attempting one *y* value)	

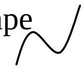
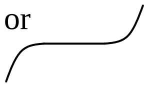
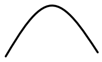
Question number	Scheme	Marks
5.	Use of $b^2 - 4ac$, perhaps implicit (e.g. in quadratic formula)	M1
	$(-3)^2 - 4 \times 2 \times -(k+1) < 0$ $\quad \left(9 + 8(k+1) < 0\right)$	A1
	$8k < -17$ $\quad$ (Manipulate to get $pk < q$, or $pk > q$, or $pk = q$)	M1
	$k < -\dfrac{17}{8}$ $\quad \left(\text{Or equiv}: k < -2\dfrac{1}{8} \text{ or } k < -2.125\right)$	A1cso (4)
		4
	1st M: Could also be, for example, comparing or equating b^2 and $4ac$. Must be considering the given quadratic equation. There must not be x terms in the expression, but there must be a k term. 1st A: Correct expression (need not be simplified) and correct inequality sign. Allow also $-3^2 - 4 \times 2 \times -(k+1) < 0$. 2nd M: Condone sign or bracketing mistakes in manipulation. Not dependent on 1st M, but should not be given for irrelevant work. M0 M1 could be scored: e.g. where $b^2 + 4ac$ is used instead of $b^2 - 4ac$. Special cases: 1. Where there are x terms in the discriminant expression, but then division by x^2 gives an inequality/equation in k. (This could score M0 A0 M1 A1). 2. Use of $\le$ instead of $<$ loses one A mark only, at first occurrence, so an otherwise correct solution leading to $k \le -\dfrac{17}{8}$ scores M1 A0 M1 A1. N.B. Use of $b = 3$ instead of $b = -3$ implies no A marks.	

Question number	Scheme	Marks
6.	(a) $(4+3\sqrt{x})(4+3\sqrt{x})$ seen, or a numerical value of k seen, $(k \neq 0)$. (The k value need not be explicitly stated… see below). $16+24\sqrt{x}+9x$, or $k = 24$ (b) $16 \to cx$ or $kx^{1/2} \to cx^{3/2}$ or $9x \to cx^2$ $\int(16+24\sqrt{x}+9x)\mathrm{d}x = 16x+\frac{9x^2}{2}+C,\ +16x^{3/2}$	M1 A1cso (2) M1 A1, A1ft (3) **5**
	(a) e.g. $(4+3\sqrt{x})(4+3\sqrt{x})$ alone scores M1 A0, (but <u>not</u> $(4+3\sqrt{x})^2$ alone). e.g $16+12\sqrt{x}+9x$ scores M1 A0. k = 24 or $16+24\sqrt{x}+9x$,with no further evidence, scores full marks M1 A1. Correct solution only (cso): any wrong working seen loses the A mark. (b) A1: $16x+\frac{9x^2}{2}+C$. Allow 4.5 or $4\frac{1}{2}$ as equivalent to $\frac{9}{2}$. A1ft: $\frac{2k}{3}x^{3/2}$ (candidate's value of k, or general k). For this final mark, allow for example $\frac{48}{3}$ as equivalent to 16, but do <u>not</u> allow unsimplified "double fractions" such as $\frac{24}{\left(\frac{3}{2}\right)}$, and do <u>not</u> allow unsimplified "products" such as $\frac{2}{3}\times 24$. A single term is required, e.g. $8x^{3/2}+8x^{3/2}$ is not enough. An otherwise correct solution with, say, C missing, followed by an incorrect solution including + C can be awarded full marks (isw, but allowing the C to appear at any stage).	

Question number	Scheme	Marks
7.	(a) $3x^2 \to cx^3$ or $-6 \to cx$ or $-8x^{-2} \to cx^{-1}$	M1
	$f(x) = \frac{3x^3}{3} - 6x - \frac{8x^{-1}}{-1}$ $(+C)$ $\left(x^3 - 6x + \frac{8}{x}\right)$	A1 A1
	Substitute x = 2 and y = 1 into a 'changed function' to form an equation in C.	M1
	$1 = 8 - 12 + 4 + C$ $C = 1$	A1cso (5)
	(b) $3 \times 2^2 - 6 - \frac{8}{2^2}$	M1
	$= 4$	A1
	Eqn. of tangent: $y - 1 = 4(x - 2)$	M1
	$y = 4x - 7$ (Must be in this form)	A1 (4)
		9
	(a) First 2 A marks: + C is not required, and coefficients need not be simplified, but powers must be simplified. All 3 terms correct: A1 A1 Two terms correct: A1 A0 Only one term correct: A0 A0 Allow the M1 A1 for finding C to be scored either in part (a) or in part (b). (b) 1st M: Substituting x = 2 into $3x^2 - 6 - \frac{8}{x^2}$ (must be this function). 2nd M: Awarded generously for attempting the equation of a straight line through (2, 1) or (1, 2) with any value of m, however found. 2nd M: Alternative is to use (2, 1) or (1, 2) in $y = mx + c$ to find a value for c. If calculation for the gradient value is seen in part (a), it must be used in part (b) to score the first M1 A1 in (b). Using (1, 2) instead of (2, 1): Loses the 2nd method mark in (a). Gains the 2nd method mark in (b).	

Question number	Scheme	Marks
8.	(a) $4x \to k$ or $3x^{3/2} \to kx^{1/2}$ or $-2x^2 \to kx$	M1
	$\frac{dy}{dx} = 4 + \frac{9}{2}x^{1/2} - 4x$	A1 A1 (3)
	(b) For $x = 4$, $y = (4\times4) + (3\times4\sqrt{4}) - (2\times16) = 16 + 24 - 32 = 8$ (*)	B1 (1)
	(c) $\frac{dy}{dx} = 4 + 9 - 16 = -3$ M: Evaluate their $\frac{dy}{dx}$ at $x = 4$	M1
	Gradient of normal = $\frac{1}{3}$	A1ft
	Equation of normal: $y - 8 = \frac{1}{3}(x-4)$, $3y = x + 20$ (*)	M1, A1 (4)
	(d) $y = 0$: $x = ...\ (-20)$ and use $(x_2 - x_1)^2 + (y_2 - y_1)^2$	M1
	$PQ = \sqrt{24^2 + 8^2}$ or $PQ^2 = 24^2 + 8^2$ Follow through from $(k, 0)$ May also be scored with $(-24)^2$ and $(-8)^2$.	A1ft
	$= 8\sqrt{10}$	A1 (3) **11**
	(a) For the 2 A marks coefficients need <u>not</u> be simplified, but powers must be simplified. For example, $\frac{3}{2}\times 3x^{1/2}$ is acceptable. All 3 terms correct: A1 A1 Two terms correct: A1 A0 Only one term correct: A0 A0 (b) There must be some evidence of the "24" value. (c) In this part, beware 'working backwards' from the given answer. A1ft: Follow through is just from the candidate's <u>value</u> of $\frac{dy}{dx}$. 2^{nd} M: Is not given if an m value appears "from nowhere". 2^{nd} M: Must be an attempt at a <u>normal</u> equation, not a tangent. 2^{nd} M: Alternative is to use (4, 8) in $y = mx + c$ to <u>find a value</u> for c. (d) M: Using the normal equation to attempt coordinates of Q, (even if using $x = 0$ instead of $y = 0$), <u>and</u> using Pythagoras to attempt PQ or PQ^2. Follow through from $(k, 0)$, but <u>not</u> from $(0, k)$… A common wrong answer is to use $x = 0$ to give $\frac{20}{3}$. This scores M1 A0 A0. For final answer, accept other simplifications of $\sqrt{640}$, e.g. $2\sqrt{160}$ or $4\sqrt{40}$.	

Question number	Scheme	Marks
9.	(a) Recognising arithmetic series with first term 4 and common difference 3. (If not scored here, this mark may be given if seen elsewhere in the solution). $a+(n-1)d = 4+3(n-1) \qquad (= 3n+1)$	B1 M1 A1 (3)
	(b) $S_n = \frac{n}{2}\{2a+(n-1)d\} = \frac{10}{2}\{8+(10-1)\times 3\}, \quad = 175$,	M1 A1, A1 (3)
	(c) $S_k < 1750: \ \frac{k}{2}\{8+3(k-1)\} < 1750 \ \left(\text{or } \ S_{k+1} > 1750: \ \frac{k+1}{2}\{8+3k\} > 1750\right)$ $3k^2+5k-3500<0 \ \left(\text{or } \ 3k^2+11k-3492>0\right)$ (Allow equivalent 3-term versions such as $3k^2+5k=3500$). $(3k-100)(k+35)<0$ Requires use of correct inequality throughout.(*)	M1 M1 A1 A1cso (4)
	(d) $\frac{100}{3}$ or equiv. <u>seen</u> $\left(\text{or } \frac{97}{3}\right)$, k = 33 (and no other values)	M1, A1 (2)
		12
	(a) B1: Usually identified by a = 4 and d = 3. M1: Attempted use of term formula for arithmetic series, or… answer in the form (3n + constant), where the constant is a non-zero value. Answer for (a) does not require simplification, and a correct answer without working scores all 3 marks. (b) M1: Use of correct sum formula with n = 9, 10 or 11. A1: Correct, perhaps unsimplified, numerical version. A1: 175 <u>Alternative</u>: (Listing and summing terms). M1: Summing 9, 10 or 11 terms. (At least 1st, 2nd and last terms must be seen). A1: Correct terms (perhaps implied by last term 31). A1: 175 <u>Alternative</u>: (Listing all sums) M1: Listing 9, 10 or 11 sums. (At least 4, 7, ….., "*last*"). A1: Correct sums, correct finishing value 175. A1: 175 <u>Alternative</u>: (Using last term). M1: Using $S_n = \frac{n}{2}(a+l)$ with T_9, T_{10} or T_{11} as the last term. A1: Correct numerical version $\frac{10}{2}(4+31)$. A1: 175 Correct answer with <u>no</u> working scores 1 mark: 1,0,0. (c) For the first 3 marks, allow <u>any inequality sign</u>, or <u>equals.</u> 1st M: Use of correct sum formula to form inequality or equation in k, with the 1750. 2nd M: (Dependent on 1st M). Form 3-term quadratic in k. 1st A: Correct 3 terms. Allow credit for part (c) if valid work is seen in part (d). (d) Allow both marks for k = 33 seen without working. Working for part (d) must be seen in part (d), not part (c).	

Question number	Scheme	Marks	
10.	(a)  (i) Shape  or  or 	B1	
	Max. at (0, 0).	B1	
	(2, 0), (or 2 shown on x-axis).	B1	(3)
	(ii) Shape  (It need not go below x-axis)	B1	
	Through origin.	B1	
	(6, 0), (or 6 shown on x-axis).	B1	(3)
	(b) $x^2(x-2) = x(6-x)$	M1	
	$x^3 - x^2 - 6x = 0$ Expand to form 3-term cubic (or 3-term quadratic if divided by x), with all terms on one side. The "= 0" may be implied.	M1	
	$x(x-3)(x+2) = 0$ $x = \ldots$ Factor x (or divide by x), and solve quadratic.	M1	
	$x = 3$ and $x = -2$	A1	
	$x = -2:$ $y = -16$ Attempt y value for a non-zero x value by substituting back into $x^2(x-2)$ or $x(6-x)$.	M1	
	$x = 3:$ $y = 9$ Both y values are needed for A1.	A1	
	$(-2, -16)$ and $(3, 9)$		
	(0, 0) This can just be written down. Ignore any 'method' shown. (But must be seen in part (b)).	B1	(7) **13**
	(a) (i) For the third 'shape' shown above, where a section of the graph coincides with the x-axis, the B1 for (2, 0) can still be awarded if the 2 is shown on the x-axis. For the final B1 in (i), and similarly for (6, 0) in (ii): There must be a sketch. If, for example (2, 0) is written <u>separately</u> from the sketch, the sketch must not clearly contradict this. If (0, 2) instead of (2, 0) is shown <u>on the sketch</u>, allow the mark. Ignore extra intersections with the x-axis. (ii) 2nd B is dependent on 1st B. Separate sketches can score all marks. (b) Note the dependence of the first three M marks. A common wrong solution is (-2, 0), (3, 0), (0, 0), which scores M0 A0 B1 as the last 3 marks. A solution using <u>no</u> algebra (e.g. trial and error), can score up to 3 marks: M0 M0 M0 A0 M1 A1 B1. (The final A1 requires both y values). Also, if the cubic is found but not solved algebraically, up to 5 marks: M1 M1 M0 A0 M1 A1 B1. (The final A1 requires both y values).		

GENERAL PRINCIPLES FOR C1 MARKING

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2+bx+c)=(x+p)(x+q)$, where $|pq|=|c|$, leading to $x = \ldots$

$(ax^2+bx+c)=(mx+p)(nx+q)$, where $|pq|=|c|$ and $|mn|=|a|$, leading to $x = \ldots$

2. Formula

Attempt to use correct formula (with values for *a*, *b* and *c*).

3. Completing the square

Solving $x^2+bx+c=0$: $(x \pm p)^2 \pm q \pm c$, $p \neq 0$, $q \neq 0$, leading to $x = \ldots$

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \to x^{n-1}$)

2. Integration

Power of at least one term increased by 1. ($x^n \to x^{n+1}$)

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values.

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but will be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

The rubric says that these may gain no credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice.

Misreads

(See the next sheet for a simple example).

A misread must be consistent for the whole question to be interpreted as such.

These are not common. In clear cases, please deduct the first 2 A (or B) marks which would have been lost by following the scheme. (Note that 2 marks is the maximum misread penalty, but that misreads which alter the nature or difficulty of the question cannot be treated so generously and it will usually be necessary here to follow the scheme as written).

Sometimes following the scheme as written is more generous to the candidate than applying the misread rule, so in this case use the scheme as written.

MISREADS

Question 7. $3x^2$ misread as $3x^3$

(a) $f(x) = \frac{3x^4}{4} - 6x - \frac{8x^{-1}}{-1}$	M1 A1 A0
$1 = 12 - 12 + 4 + C \quad C = -3$	M1 A0
(b) $m = 3 \times 2^3 - 6 - \frac{8}{2^2} = 16$	M1 A1
Eqn. of tangent: $y - 1 = 16(x - 2)$	M1
$y = 16x - 31$	A1