Mark Scheme (Results)
January 2010

GCE

Core Mathematics C1 (6663)

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Question number	Scheme	Marks
Q1	$x^4 \to kx^3$ or $x^{1/3} \to kx^{-2/3}$ or $3 \to 0$ (k a non-zero constant)	M1
	$\left(\frac{\mathrm{d}y}{\mathrm{d}x}=\right)$ $4x^3$.......... , with '3' differentiated to zero (or 'vanishing')	A1
	$\left(\frac{\mathrm{d}y}{\mathrm{d}x}=\right)$ .... $+\frac{1}{3}x^{-2/3}$ or equivalent, e.g. $\frac{1}{3\sqrt[3]{x^2}}$ or $\frac{1}{3\left(\sqrt[3]{x}\right)^2}$	A1
		[3]
	1st A1 requires $4x^3$, <u>and</u> 3 differentiated to zero. Having '+C' loses the 1st A mark. Terms not added, but otherwise correct, e.g. $4x^3$, $\frac{1}{3}x^{-2/3}$ loses the 2nd A mark.	

Question number	Scheme	Marks
Q2	(a) $(7+\sqrt{5})(3-\sqrt{5}) = 21-5+3\sqrt{5}-7\sqrt{5}$ Expand to get 3 or 4 terms $= 16, \ -4\sqrt{5}$ (1st A for 16, 2nd A for $-4\sqrt{5}$) (i.s.w. if necessary, e.g. $16-4\sqrt{5} \rightarrow 4-\sqrt{5}$)	M1 A1, A1 (3)
	(b) $\frac{7+\sqrt{5}}{3+\sqrt{5}} \times \frac{3-\sqrt{5}}{3-\sqrt{5}}$ (This is sufficient for the M mark) Correct denominator without surds, i.e. $9-5$ or 4 $4-\sqrt{5}$ or $4-1\sqrt{5}$	M1 A1 A1 (3) [6]
	(a) M1: Allowed for an attempt giving 3 or 4 terms, with at least 2 correct (even if unsimplified). e.g. $21-\sqrt{5}^2+\sqrt{15}$ scores M1. Answer only: $16-4\sqrt{5}$ scores full marks One term correct scores the M mark by implication, e.g. $26-4\sqrt{5}$ scores M1 A0 A1 (b) Answer only: $4-\sqrt{5}$ scores full marks One term correct scores the M mark by implication, e.g. $4+\sqrt{5}$ scores M1 A0 A0 $16-\sqrt{5}$ scores M1 A0 A0 Ignore subsequent working, e.g. $4-\sqrt{5}$ so $a=4$, $b=1$ Note that, as always, A marks are dependent upon the preceding M mark, so that, for example, $\frac{7+\sqrt{5}}{3+\sqrt{5}} \times \frac{3+\sqrt{5}}{3-\sqrt{5}} = \frac{\ldots\ldots\ldots}{4}$ is M0 A0. <u>Alternative</u> $(a+b\sqrt{5})(3+\sqrt{5}) = 7+\sqrt{5}$, then form simultaneous equations in a and b. M1 Correct equations: $3a+5b=7$ and $3b+a=1$ A1 $a=4$ and $b=-1$ A1	

Question number	Scheme	Marks
Q3	(a) Putting the equation in the form $y = mx\ (+c)$ <u>and</u> attempting to extract the m or mx (<u>not</u> the c), or finding 2 points on the line and using the correct gradient formula. Gradient = $-\frac{3}{5}$ (or equivalent)	M1 A1 (2)
	(b) Gradient of perp. line = $\frac{-1}{"\left(-\frac{3}{5}\right)"}$ (Using $-\frac{1}{m}$ with the m from part (a)) $y - 1 = "\left(\frac{5}{3}\right)"(x - 3)$ $y = \frac{5}{3}x - 4$ (Must be in this form... allow $y = \frac{5}{3}x - \frac{12}{3}$ but not $y = \frac{5x - 12}{3}$) This A mark is dependent upon <u>both</u> M marks.	M1 M1 A1 (3) [5]
	(a) Condone sign errors and ignore the c for the M mark, so... both marks can be scored even if c is wrong (e.g. $c = -\frac{2}{5}$) or omitted. <u>Answer only</u>: $-\frac{3}{5}$ scores M1 A1. Any other <u>answer only</u> scores M0 A0. $y = -\frac{3}{5}x + \frac{2}{5}$ with no further progress scores M0 A0 (m or mx not extracted). (b) 2nd M: For the equation, in any form, of a straight line through (3, 1) with <u>any</u> numerical gradient (except 0 or ∞). (Alternative is to use (3, 1) in $y = mx + c$ to <u>find a value</u> for c, in which case $y = \frac{5}{3}x + c$ leading to $c = -4$ is sufficient for the A1). (See general principles for straight line equations at the end of the scheme).	

Question number	Scheme	Marks
Q4	$x\sqrt{x} = x^{\frac{3}{2}}$ (Seen, or implied by correct integration)	B1
	$x^{-\frac{1}{2}} \to kx^{\frac{1}{2}}$ or $x^{\frac{3}{2}} \to kx^{\frac{5}{2}}$ (k a non-zero constant)	M1
	$(y =)\ \dfrac{5x^{\frac{1}{2}}}{\frac{1}{2}} \ldots + \dfrac{x^{\frac{5}{2}}}{\frac{5}{2}}\ (+C)$ ("$y =$" and " $+C$" are not required for these marks)	A1…A1
	$35 = \dfrac{5\times 4^{\frac{1}{2}}}{\frac{1}{2}} + \dfrac{4^{\frac{5}{2}}}{\frac{5}{2}} + C$ An equation in C is required (see conditions below). (With their terms simplified or unsimplified).	M1
	$C = \dfrac{11}{5}$ or equivalent $2\dfrac{1}{5}$, 2.2	A1
	$y = 10x^{\frac{1}{2}} + \dfrac{2x^{\frac{5}{2}}}{5} + \dfrac{11}{5}$ (Or equivalent simplified)	A1 ft
	I.s.w. if necessary, e.g. $y = 10x^{\frac{1}{2}} + \dfrac{2x^{\frac{5}{2}}}{5} + \dfrac{11}{5} = 50x^{\frac{1}{2}} + 2x^{\frac{5}{2}} + 11$ The final A mark requires an equation "$y = \ldots$" with correct x terms (see below).	[7]
	B mark: $x^{\frac{3}{2}}$ often appears from integration of $\sqrt{x}$, which is B0. 1st A: Any unsimplified or simplified correct form, e.g. $\dfrac{5\sqrt{x}}{0.5}$. 2nd A: Any unsimplified or simplified correct form, e.g. $\dfrac{x^2\sqrt{x}}{2.5}$, $\dfrac{2(\sqrt{x})^5}{5}$. 2nd M: Attempting to use $x = 4$ and $y = 35$ in a changed function (even if differentiated) to form an equation in C. 3rd A: Obtaining $C = \dfrac{11}{5}$ with no earlier incorrect work. 4th A: Follow-through only the value of C (i.e. the other terms must be correct). Accept equivalent simplified terms such as $10\sqrt{x} + 0.4x^2\sqrt{x}$ ...	

Question number	Scheme	Marks
Q5	$y = 3x - 2 \qquad (3x-2)^2 - x - 6x^2 (= 0)$	M1
	$9x^2 - 12x + 4 - x - 6x^2 = 0$ $3x^2 - 13x + 4 = 0$ (or equiv., e.g. $3x^2 = 13x - 4$)	M1 A1cso
	$(3x-1)(x-4) = 0 \qquad x = \ldots \qquad x = \frac{1}{3}$ (or exact equivalent) $\quad x = 4$	M1 A1
	$y = -1 \quad y = 10$ (Solutions need not be "paired")	M1 A1
		[7]

1st M: Obtaining an equation in x only (or y only). Condone missing "= 0"
Condone sign slips, e.g. $(3x+2)^2 - x - 6x^2 = 0$, but not other algebraic mistakes (such as squaring individual terms... see bottom of page).

2nd M: Multiplying out their $(3x-2)^2$, which must lead to a 3 term quadratic, i.e. $ax^2 + bx + c$, where $a \neq 0,\ b \neq 0,\ c \neq 0$, and collecting terms.

3rd M: Solving a 3-term quadratic (see general principles at end of scheme).
2nd A: Both values.
4th M: Using an x value, found algebraically, to attempt at least one y value (or using a y value, found algebraically, to attempt at least one x value)… allow b.o.d. for this mark in cases where the value is wrong but working is not shown.
3rd A: Both values.

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.

"Non-algebraic" solutions:
No working, and only one correct solution pair found (e.g. $x = 4$, $y = 10$):
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: Full marks

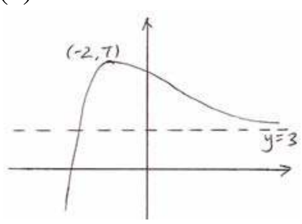
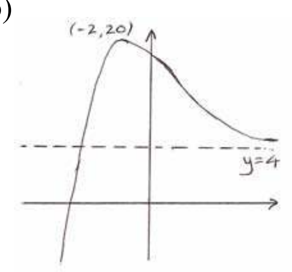
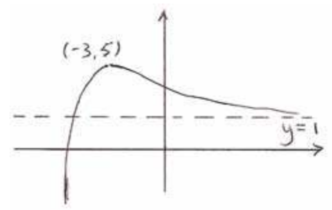
Alternative:

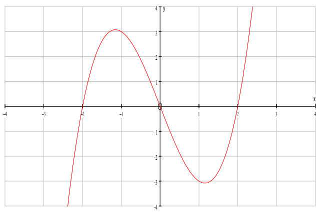
$x = \dfrac{y+2}{3} \qquad y^2 - \dfrac{y+2}{3} - 6\left(\dfrac{y+2}{3}\right)^2 = 0$		M1
$y^2 - \dfrac{y+2}{3} - 6\left(\dfrac{y^2+4y+4}{9}\right) = 0$	$y^2 - 9y - 10 = 0$	M1 A1
$(y+1)(y-10) = 0 \qquad y = \ldots$	$y = -1 \quad y = 10$	M1 A1
	$x = \dfrac{1}{3} \quad x = 4$	M1 A1

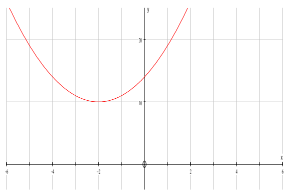
Squaring each term in the first equation,
e.g. $y^2 - 9x^2 + 4 = 0$, and using this to obtain an equation in x only could score at most 2 marks: M0 M0 A0 M1 A0 M1 A0.

Question number	Scheme	Marks
Q6	(a) $y=\frac{x^2-5x-24}{x}=x-5-24x^{-1}$ (or equiv., e.g. $x+3-8-\frac{24}{x}$)	M1 A1
	$\frac{dy}{dx}=1+24x^{-2}$ or $\frac{dy}{dx}=1+\frac{24}{x^2}$	M1 A1 (4)
	(b) $x=2$: $y=-15$ Allow if seen in part (a).	B1
	$\left(\frac{dy}{dx}=\right)$ $1+\frac{24}{4}=7$ Follow-through from candidate's <u>non-constant</u> $\frac{dy}{dx}$. This must be simplified to a "single value".	B1ft
	$y+15=7(x-2)$ (or equiv., e.g. $y=7x-29$) Allow $\frac{y+15}{x-2}=7$	M1 A1 (4) [8]
	(a) 1st M: Mult. out to get $x^2+bx+c,\ b\neq 0,\ c\neq 0$ <u>and</u> dividing by x (<u>not</u> x^2). Obtaining one correct term, e.g. x…….. is sufficient evidence of a division attempt. 2nd M: <u>Dependent on the 1st M</u>: Evidence of $x^n \to kx^{n-1}$ for one x term (i.e. not just the constant term) is sufficient). Note that mark is <u>not</u> given if, for example, the numerator and denominator are differentiated separately. A mistake in the 'middle term', e.g. $x+5-24x^{-1}$, does not invalidate the 2nd A mark, so M1 A0 M1 A1 is possible. (b) B1ft: For evaluation, using $x=2$, of their $\frac{dy}{dx}$, even if unlabelled or called y. M: For the equation, in any form, of a straight line through (2, '−15') with candidate's $\frac{dy}{dx}$ value as gradient. Alternative is to use (2, '−15') in $y=mx+c$ to <u>find a value</u> for c, in which case $y=7x+c$ leading to $c=-29$ is sufficient for the A1). . (See general principles for straight line equations at the end of the scheme). Final A: 'Unsimplified' forms are acceptable, but… $y-(-15)=7(x-2)$ is A0 (unresolved 'minus minus').	

Question number	Scheme	Marks
Q7	(a) $a+9d=150+9\times 10=240$	M1 A1 (2)
	(b) $\frac{1}{2}n\{2a+(n-1)d\}=\frac{20}{2}\{2\times 150+19\times 10\},\ =4900$	M1 A1, A1 (3)
	(c) Kevin: $\frac{1}{2}n\{2a+(n-1)d\}=\frac{20}{2}\{2A+19\times 30\}$ Kevin's total = $2\times$"4900" (or "4900" = $2\times$ Kevin's total) $\frac{20}{2}\{2A+19\times 30\}=2\times$"4900" $A=205$	B1 M1 A1ft A1 (4) [9]
	(a) M: Using $a+9d$ with at least one of a = 150 and d = 10. Being 'one off' (e.g. equivalent to a + 10d), scores M0. Correct answer with no working scores both marks. (b) M: Attempting to use the correct sum formula to obtain S_{20}, with at least one of a = 150 and d = 10. If the wrong value of n or a or d is used, the M mark is only scored if the correct sum formula has been quoted. 1st A: Any fully correct numerical version. (c) B: A correct expression, in terms of A, for Kevin's total. M: Equating Kevin's total to twice Jill's total, or Jill's total to twice Kevin's. For this M mark, the expression for Kevin's total need not be correct, but must be a linear function of A (or a). 1st A: (Kevin's total, <u>correct</u>, possibly unsimplified) = 2(Jill's total), ft Jill's total from part (b). <u>'Listing' and other methods</u> (a) M: Listing terms (found by a correct method with at least one of a = 150 and d = 10), and picking the <u>10th</u> term. (There may be numerical slips). (b) M: Listing sums, or listing and adding terms (found by a correct method with at least one of a = 150 and d = 10), far enough to establish the required sum. (There may be numerical slips). Note: <u>20th term is 340</u>. A2 (scored as A1 A1) for 4900 (clearly selected as the answer). If no working (or no legitimate working) is seen, but the answer 4900 is given, allow one mark (scored as M1 A0 A0). (c) <u>By trial and improvement</u>: Obtaining a value of A for which Kevin's total is twice Jill's total, or Jill's total is twice Kevin's (using Jill's total from (b)): M1 Obtaining a value of A for which Kevin's total is twice Jill's total (using Jill's total from (b)): A1ft Fully correct solutions then score the B1 and final A1. The answer 205 with no working (or no legitimate working) scores no marks.	

Question number	Scheme	Marks
Q8	(a)  (b)  (c) 	
	(a) $(-2, 7)$, $y = 3$ (Marks are dependent upon a sketch being attempted) See conditions below.	B1, B1 (2)
	(b) $(-2, 20)$, $y = 4$ (Marks are dependent upon a sketch being attempted) See conditions below.	B1, B1 (2)
	(c) Sketch: Horizontal translation (either way)… (There must be evidence that $y = 5$ at the max and that the asymptote is still $y = 1$) $(-3, 5)$, $y = 1$	B1 B1, B1 (3) [7]
	Parts (a) and (b): (i) If only one of the B marks is scored, there is no penalty for a wrong sketch. (ii) If both the maximum and the equation of the asymptote are correct, the sketch must be "correct" to score B1 B1. If the sketch is "wrong", award B1 B0. The (generous) conditions for a "correct" sketch are that the maximum must be in the 2nd quadrant and that the curve must not cross the positive x-axis... ignore other "errors" such as "curve appearing to cross its asymptote" and "curve appearing to have a minimum in the 1st quadrant". Special case: (b) Stretch $\frac{1}{4}$ instead of 4: Correct shape, with $\left(-2, \frac{5}{4}\right)$, $y = \frac{1}{4}$: B1 B0. Coordinates of maximum: If the coordinates are the wrong way round (e.g. $(7, -2)$ in part (a)), or the coordinates are just shown as values on the x and y axes, penalise only once in the whole question, at first occurrence. Asymptote marks: If the equation of the asymptote is not given, e.g. in part (a), 3 is marked on the y-axis but $y = 3$ is not seen, penalise only once in the whole question, at first occurrence. Ignore extra asymptotes stated (such as $x = 0$).	

Question number	Scheme	Marks
Q9	(a) $x(x^2-4)$ Factor x seen in a <u>correct</u> factorised form of the expression. $= x(x-2)(x+2)$ M: Attempt to factorise quadratic (general principles). Accept $(x-0)$ or $(x+0)$ instead of x at any stage. Factorisation must be seen in part (a) to score marks.	B1 M1 A1 (3)
	(b)  Shape (2 turning points required) Through (or touching) origin Crossing x-axis or "stopping at x-axis" (<u>not</u> a turning point) at (–2, 0) and (2, 0). Allow –2 and 2 on x-axis. Also allow (0, –2) and (0, 2) if marked on x-axis. Ignore extra intersections with x-axis.	B1 B1 B1 (3)
	(c) <u>Either</u> $y = 3$ (at $x = -1$) <u>or</u> $y = 15$ (at $x = 3$) Allow if seen elsewhere. Gradient $= \dfrac{"15-3"}{3-(-1)}$ $(=3)$ Attempt correct grad. formula with their y values. For gradient M mark, if correct formula not seen, allow one slip, e.g. $\dfrac{"15-3"}{3-1}$ $y - "15" = m(x-3)$ or $y - "3" = m(x-(-1))$, with any value for m. $y - 15 = 3(x-3)$ or the <u>correct</u> equation in <u>any</u> form, e.g. $y - 3 = \dfrac{15-3}{3-(-1)}(x-(-1))$, $\dfrac{y-3}{x+1} = \dfrac{15-3}{3+1}$ $y = 3x+6$	B1 M1 M1 A1 A1 (5)
	(d) $AB = \sqrt{("15-3")^2 + (3-(-1))^2}$ (With their <u>non-zero</u> y values)... Square root is required. $= \sqrt{160}$ $\left(= \sqrt{16}\sqrt{10}\right) = 4\sqrt{10}$ (Ignore ± if seen) ($\sqrt{16}\sqrt{10}$ need not be seen).	M1 A1 (2) [13]
	(a) $x^3-4x \rightarrow x(x^2-4) \rightarrow (x-2)(x+2)$ scores B1 M1 A0. $x^3-4x \rightarrow x^2-4 \rightarrow (x-2)(x+2)$ scores B0 M1 A0 (dividing by x). $x^3-4x \rightarrow x(x^2-4x) \rightarrow x^2(x-4)$ scores B0 M1 A0. $x^3-4x \rightarrow x(x^2-4) \rightarrow x(x-2)^2$ scores B1 M1 A0 Special cases: $x^3-4x \rightarrow (x-2)(x^2+2x)$ scores B0 M1 A0. $x^3-4x \rightarrow x(x-2)^2$ (with no intermediate step seen) scores B0 M1 A0 (b) The 2nd and 3rd B marks are not dependent upon the 1st B mark, but <u>are</u> dependent upon a sketch having been attempted. (c) 1st M: May be implicit in the equation of the line, e.g. $\dfrac{y-"15"}{3-"15"} = \dfrac{x-"3"}{-1-"3"}$ 2nd M: An equation of a line through (3, "15") or (–1, "3") <u>in any form</u>, with any gradient (except 0 or ∞). 2nd M: Alternative is to use one of the points in $y = mx + c$ to <u>find a value</u> for c, in which case $y = 3x + c$ leading to $c = 6$ is sufficient for both A marks. 1st A1: <u>Correct</u> equation in <u>any</u> form.	

Question number	Scheme	Marks
Q10	(a) $(x+2k)^2$ or $\left(x+\frac{4k}{2}\right)^2$	M1
	$(x\pm F)^2 \pm G \pm 3 \pm 11k$ (where F and G are any functions of k, not involving x)	M1
	$(x+2k)^2-4k^2+(3+11k)$ Accept unsimplified equivalents such as $\left(x+\frac{4k}{2}\right)^2-\left(\frac{4k}{2}\right)^2+3+11k$, and i.s.w. if necessary.	A1 (3)
	(b) Accept part (b) solutions seen in part (a).	
	$"4k^2-11k-3"=0$ $(4k+1)(k-3)=0$ $k=\ldots,$ [Or, 'starting again', $b^2-4ac=(4k)^2-4(3+11k)$ and proceed to $k=\ldots$]	M1
	$-\frac{1}{4}$ and 3 (Ignore any inequalities for the first 2 marks in (b)).	A1
	Using $b^2-4ac<0$ for no real roots, i.e. $"4k^2-11k-3"<0$, to establish inequalities involving their two critical values m and n (even if the inequalities are wrong, e.g. $k<m$, $k<n$).	M1
	$-\frac{1}{4}<k<3$ (See conditions below) Follow through their critical values. The final A1ft is still scored if the answer $m<k<n$ follows $k<m$, $k<n$. Using x instead of k in the final answer loses only the 2nd A mark, (condone use of x in earlier working).	A1ft (4)
	(c)  Shape $\cup$ (seen in (c))	B1
	Minimum in correct quadrant, not touching the x-axis, not on the y-axis, and there must be no other minimum or maximum.	B1
	(0, 14) or 14 on y-axis. Allow (14, 0) marked on y-axis.	B1 (3)
	n.b. Minimum is at $(-2,10)$, (but there is no mark for this).	[10]
	(b) 1st M: Forming and solving a 3-term quadratic in k (usual rules.. see general principles at end of scheme). The quadratic must come from $"b^2-4ac"$, or from the $"q"$ in part (a). Using wrong discriminant, e.g. $"b^2+4ac"$ will score no marks in part (b). 2nd M: As defined in main scheme above. 2nd A1ft: $m<k<n$, where $m<n$, for their critical values m and n. Other possible forms of the answer (in each case $m<n$): (i) $n>k>m$ (ii) $k>m$ and $k<n$ In this case the word "and" must be seen (implying intersection). (iii) $k\in(m,n)$ (iv) $\{k:k>m\}\cap\{k:k<n\}$ Not just a number line. Not just $k>m$, $k<n$ (without the word "and"). (c) Final B1 is dependent upon a sketch having been attempted in part (c).	

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