June 2009
6663 Core Mathematics C1
Mark Scheme

Question Number	Scheme	Marks
Q1 (a) (b)	$(3\sqrt{7})^2 = 63$ $(8+\sqrt{5})(2-\sqrt{5}) = 16-5+2\sqrt{5}-8\sqrt{5}$ $= 11, \ -6\sqrt{5}$	B1 (1) M1 A1, A1 (3) **[4]**
(a) (b)	B1 for 63 only M1 for an attempt to expand <u>their</u> brackets with $\geq$ 3 terms correct. They may collect the $\sqrt{5}$ terms to get $16-5-6\sqrt{5}$ Allow $-\sqrt{5}\times\sqrt{5}$ or $-\left(\sqrt{5}\right)^2$ or $-\sqrt{25}$ instead of the -5 These 4 values may appear in a list or table but they should have minus signs included **The next two marks should be awarded for the final answer but check that correct values follow from correct working. Do not use ISW rule** 1st A1 for 11 from 16 – 5 <u>or</u> $-6\sqrt{5}$ from $-8\sqrt{5}+2\sqrt{5}$ 2nd A1 for <u>both</u> 11 and $-6\sqrt{5}$. <u>S.C - Double sign error in expansion</u> For $16-5-2\sqrt{5}+8\sqrt{5}$ leading to 11 + … allow <u>one</u> mark	

Question Number	Scheme	Marks
Q2	$32 = 2^5$ or $2048 = 2^{11}$, $\sqrt{2} = 2^{1/2}$ or $\sqrt{2048} = (2048)^{\frac{1}{2}}$	B1, B1
	$a = \frac{11}{2}$ $\left(\text{or } 5\frac{1}{2} \text{ or } 5.5\right)$	B1
		[3]
	1st B1 for $32 = 2^5$ or $2048 = 2^{11}$ This should be explicitly seen: $32\sqrt{2} = 2^a$ followed by $2^5\sqrt{2} = 2^a$ is OK Even writing $32 \times 2 = 2^5 \times 2\left(= 2^6\right)$ is OK but simply writing $32 \times 2 = 2^6$ is NOT 2nd B1 for $2^{\frac{1}{2}}$ or $(2048)^{\frac{1}{2}}$ seen. This mark may be implied 3rd B1 for answer as written. **Need *a* =** … so $2^{\frac{11}{2}}$ is B0 $a = \frac{11}{2}$ $\left(\text{or } 5\frac{1}{2} \text{ or } 5.5\right)$ with no working scores full marks. If $a = 5.5$ seen then award 3/3 unless it is clear that the value follows from totally incorrect work. Part solutions: e.g. $2^5\sqrt{2}$ scores the first B1. <u>Special case</u>: If $\sqrt{2} = 2^{1/2}$ is not explicitly seen, but the final answer includes $\frac{1}{2}$, e.g. $a = 2\frac{1}{2}$, $a = 4\frac{1}{2}$, the second B1 is given by implication.	

Question Number	Scheme	Marks
Q3 (a)	$\frac{dy}{dx} = 6x^2 - 6x^{-3}$	M1 A1 A1 (3)
(b)	$\frac{2x^4}{4} + \frac{3x^{-1}}{-1} (+C)$	M1 A1
	$\frac{x^4}{2} - 3x^{-1} + C$	A1 (3) **[6]**
(a)	M1 for an attempt to differentiate $x^n \to x^{n-1}$ 1st A1 for $6x^2$ 2nd A1 for $-6x^{-3}$ or $-\frac{6}{x^3}$ Condone $+ -6x^{-3}$ here. Inclusion of $+c$ scores A0 here.	
(b)	M1 for some attempt to integrate an x term of the given y. $x^n \to x^{n+1}$ 1st A1 for **both** x terms correct but unsimplified- as printed or better. Ignore $+c$ here 2nd A1 for both x terms correct and simplified and $+c$. Accept $-\frac{3}{x}$ but NOT $+ -3x^{-1}$ Condone the $+c$ appearing on the first (unsimplified) line but missing on the final (simplified) line Apply ISW if a correct answer is seen If part (b) is attempted first and this is clearly labelled then apply the scheme and allow the marks. Otherwise assume the first solution is for part (a).	

Question Number	Scheme	Marks
Q4 (a)	$5x > 10$, $x > 2$ [Condone $x > \frac{10}{2} = 2$ for M1A1]	M1, A1 (2)
(b)	$(2x+3)(x-4) = 0$, 'Critical values' are $-\dfrac{3}{2}$ and 4	M1, A1
	$-\dfrac{3}{2} < x < 4$	M1 A1ft (4)
(c)	$2 < x < 4$	B1ft (1) **[7]**
(a)	M1 for attempt to collect like terms on each side leading to $ax > b$, or $ax < b$, or $ax = b$ Must have a or b correct so eg $3x > 4$ scores M0	
(b)	1st M1 for an attempt to factorize or solve to find critical values. Method must potentially give 2 critical values 1st A1 for $-\dfrac{3}{2}$ and 4 seen. They may write $x < -\dfrac{3}{2}$, $x < 4$ and still get this A1 2nd M1 for choosing the "inside region" for their critical values 2nd A1ft follow through their 2 distinct critical values Allow $x > -\dfrac{3}{2}$ with "or" "," "$\cup$" " " $x < 4$ to score M1A0 but "and" or "$\cap$ " score M1A1 $x \in (-\frac{3}{2}, 4)$ is M1A1 but $x \in [-\frac{3}{2}, 4]$ is M1A0. Score M0A0 for a number line or graph only	
(c)	B1ft Allow if **a correct answer is seen** or follow through their answer to (a) and their answer to (b) but their answers to (a) and (b) must be regions. Do not follow through single values. If their follow through answer is the empty set accept $\varnothing$ or {} or equivalent in words If (a) or (b) are not given then score this mark for cao NB You may see x<4 (with anything or nothing in-between) x < -1.5 in (b) and empty set in (c) for B1ft **Do not award marks for part (b) if only seen in part (c)** Use of ≤ instead of < (or ≥ instead of >) loses one accuracy mark only, at first occurrence.	

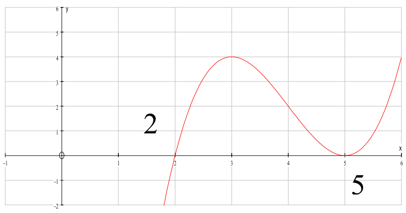
Question Number	Scheme	Marks
Q5 (a)	$a+9d=2400 \qquad a+39d=600$	M1
	$d=\dfrac{-1800}{30} \qquad d=-60 \qquad$ (accept $\pm$ 60 for A1)	M1 A1 (3)
(b)	$a-540=2400 \qquad a=2940$	M1 A1 (2)
(c)	Total = $\dfrac{1}{2}n\{2a+(n-1)d\}=\dfrac{1}{2}\times 40\times(5880+39\times -60)$ (ft values of a and d)	M1 A1ft
	$=\underline{70\ 800}$	A1cao (3) **[8]**
	Note: If the sequence is considered 'backwards', an equivalent solution may be given using d = 60 with a = 600 and l = 2940 for part (b). This can still score full marks. **Ignore labelling of (a) and (b)**	
(a)	1st M1 for an attempt to use 2400 and 600 in $a+(n-1)d$ formula. Must use both values i.e. need $a + pd = 2400$ <u>and</u> $a + qd = 600$ where p = 8 or 9 and q = 38 or 39 (any combination) 2nd M1 for an attempt to solve <u>their</u> 2 linear equations in a and d as far as d =… A1 for $d = \pm 60$. Condone correct equations leading to d = 60 or $a + 8d = 2400$ and $a + 38d = 600$ leading to d = - 60. They should get penalised in (b) and (c). **NB This is a "one off" ruling for A1. Usually an A mark must follow from their work.** ALT 1st M1 for $(30d) = \pm(2400 - 600)$ 2nd M1 for $(d=)\pm\dfrac{(2400-600)}{30}$ A1 for $d = \pm 60$ $a + 9d = 600$, $a + 39d = 2400$ **only** scores M0 BUT if they solve to find $d = \pm 60$ then use ALT scheme above.	
(b)	M1 for use of <u>their</u> d in a **correct** linear equation to find a leading to a = … A1 their a must be compatible with their d so d = 60 must have a = 600 and d = -60, a = 2940 So for example they can have $2400 = a + 9(60)$ leading to a = … for M1 but it scores A0 Any approach using a list scores M1A1 for a correct a but M0A0 otherwise	
(c)	M1 for use of a correct S_n formula with n = 40 and at least one of a, d or l correct or correct ft. 1st A1ft for use of a correct S_{40} formula and both a, d or a, l correct or correct follow through ALT Total = $\dfrac{1}{2}n\{a+l\}=\dfrac{1}{2}\times 40\times(2940+600)$ (ft value of a) M1 A1ft 2nd A1 for 70800 only	

Question Number	Scheme	Marks
Q6	$b^2 - 4ac$ attempted, in terms of p. $(3p)^2 - 4p = 0$ o.e. Attempt to solve for p e.g. $p(9p-4) = 0$ Must potentially lead to $p = k,\ k \neq 0$ $p = \frac{4}{9}$ (Ignore $p = 0$, if seen)	M1 A1 M1 A1cso **[4]**
	1st M1 for an attempt to substitute into $b^2 - 4ac$ or $b^2 = 4ac$ with b or c correct Condone x's in one term only. This can be inside a square root as part of the quadratic formula for example. **Use of inequalities can score the M marks only** 1st A1 for any correct equation: $(3p)^2 - 4 \times 1 \times p = 0$ or better 2nd M1 for an attempt to factorize or solve their quadratic expression in p. Method must be sufficient to lead to their $p = \frac{4}{9}$. Accept factors or use of quadratic formula or $\left(p \pm \frac{2}{9}\right)^2 = k^2$ (o.e. eg) $\left(3p \pm \frac{2}{3}\right)^2 = k^2$ or equivalent work on <u>their</u> eqn. $9p^2 = 4p \Rightarrow \frac{9p^{\cancel{2}}}{\cancel{p}} = 4$ which would lead to $9p = 4$ is OK for this 2nd M1 ALT <u>Comparing coefficients</u> M1 for $(x+\alpha)^2 = x^2 + \alpha^2 + 2\alpha x$ and A1 for a correct equation eg $3p = 2\sqrt{p}$ M1 for forming solving leading to $\sqrt{p} = \frac{2}{3}$ or better <u>Use of quadratic/discriminant formula (or any formula) Rule for awarding M mark</u> If the formula is quoted accept some correct substitution leading to a partially correct expression. If the formula is not quoted only award for a fully correct expression using their values.	

Question Number	Scheme	Marks
Q7 (a)	$(a_2 =)2k-7$	B1 (1)
(b)	$(a_3 =)2(2k-7)-7$ or $4k-14-7, = 4k-21$ (*)	M1, A1cso (2)
(c)	$(a_4 =)2(4k-21)-7 \quad (= 8k-49)$	M1
	$\sum_{r=1}^{4} a_r = k + "(2k-7)" + (4k-21) + "(8k-49)"$	M1
	$k + (2k-7) + (4k-21) + (8k-49) = 15k - 77 = 43 \qquad k = 8$	M1 A1 (4) **[7]**
(b) (c)	M1 must see 2(their a_2) - 7 or $2(2k-7)-7$ or $4k - 14 - 7$. Their a_2 must be a function of *k*. A1cso must see the $2(2k-7)-7$ or $4k - 14 - 7$ expression and the $4k$ - 21 with no incorrect working 1st M1 for an attempt to find a_4 using the given rule. Can be awarded for $8k$ - 49 seen. **Use of formulae for the sum of an arithmetic series scores M0M0A0 for the next 3 marks.** 2nd M1 for attempting the sum of the 1st 4 terms. Must have "+" not just , or clear attempt to sum. Follow through their a_2 and a_4 provided they are linear functions of *k*. Must lead to linear expression in *k*. Condone use of their linear $a_3 \neq 4k-21$ here too. 3rd M1 for forming a linear equation in *k* using their sum and the 43 and attempt to solve for *k* as far as $pk = q$ A1 for *k* = 8 only so $k = \frac{120}{15}$ is A0 Answer Only (e.g. trial improvement) Accept *k* = 8 only if 8 + 9 + 11 + 15 = 43 is seen as well Sum $\underline{a_2 + a_3 + a_4 + a_5}$ or $\underline{a_2 + a_3 + a_4}$ Allow: M1 if $8k$ - 49 is seen, M0 for the sum (since they are not adding the 1st 4 terms) then M1 if they use their sum along with the 43 to form a linear equation and attempt to solve but A0	

Question Number	Scheme	Marks
Q8 (a)	AB: $m = \frac{2-7}{8-6}$, $\left(= -\frac{5}{2}\right)$	B1
	Using $m_1 m_2 = -1$: $m_2 = \frac{2}{5}$	M1
	$y - 7 = \frac{2}{5}(x - 6)$, $2x - 5y + 23 = 0$ (o.e. with integer coefficients)	M1, A1 (4)
(b)	Using $x = 0$ in the answer to (a), $y = \frac{23}{5}$ or 4.6	M1, A1ft (2)
(c)	Area of triangle = $\frac{1}{2} \times 8 \times \frac{23}{5} = \frac{92}{5}$ (o.e) e.g. $\left(18\frac{2}{5},\ 18.4,\ \frac{184}{10}\right)$	M1 A1 (2)
		[8]
(a)	B1 for an expression for the gradient of AB. Does not need the $= -2.5$ 1st M1 for use of the perpendicular gradient rule. Follow through their m 2nd M1 for the use of (6, 7) and their changed gradient to form an equation for l. Can be awarded for $\frac{y-7}{x-6} = \frac{2}{5}$ o.e. Alternative is to use (6, 7) in $y = mx + c$ to <u>find a value</u> for c. Score when $c = \ldots$ is reached. A1 for a correct equation in the required form and must have "= 0" and integer coefficients	
(b)	M1 for using $x = 0$ in their answer to part (a) e.g. $-5y + 23 = 0$ A1ft for $y = \frac{23}{5}$ provided that $x = 0$ clearly seen <u>or</u> C (0, 4.6). Follow through their equation in (a) If $x = 0$, $y = 4.6$ are clearly seen but C is given as (4.6,0) apply ISW and award the mark. This A mark requires a simplified fraction or an exact decimal Accept their 4.6 marked on diagram next to C for M1A1ft	
(c)	M1 for $\frac{1}{2} \times 8 \times y_C$ so can follow through their y coordinate of C. A1 for 18.4 (o.e.) but their y coordinate of C must be positive <u>Use of 2 triangles or trapezium and triangle</u> Award M1 when an expression for area of OCB only is seen <u>Determinant approach</u> Award M1 when an expression containing $\frac{1}{2} \times 8 \times y_C$ is seen	

Question Number	Scheme	Marks
Q9 (a)	$\left[(3-4\sqrt{x})^2=\right]9-12\sqrt{x}-12\sqrt{x}+(-4)^2x$	M1
	$9x^{-\frac{1}{2}}+16x^{\frac{1}{2}}-24$	A1, A1 (3)
(b)	$f'(x)=-\frac{9}{2}x^{-\frac{3}{2}},\ +\frac{16}{2}x^{-\frac{1}{2}}$	M1 A1, A1ft (3)
(c)	$f'(9)=-\frac{9}{2}\times\frac{1}{27}+\frac{16}{2}\times\frac{1}{3}=-\frac{1}{6}+\frac{16}{6}=\frac{5}{2}$	M1 A1 (2) **[8]**
(a)	M1 for an attempt to expand $(3-4\sqrt{x})^2$ with at least 3 terms correct- as printed or better <u>Or</u> $9-k\sqrt{x}+16x\ \ (k\neq 0)$. See also the MR rule below 1st A1 for their coefficient of $\sqrt{x}$ = 16. Condone writing $(\pm)9x^{(\pm)\frac{1}{2}}$ instead of $9x^{-\frac{1}{2}}$ 2nd A1 for B = - 24 or their constant term = - 24	
(b)	M1 for an attempt to differentiate an x term $x^n\to x^{n-1}$ 1st A1 for $-\frac{9}{2}x^{-\frac{3}{2}}$ <u>and</u> their constant B differentiated to zero. NB $-\frac{1}{2}\times 9x^{-\frac{3}{2}}$ is A0 2nd A1ft follow through their $Ax^{\frac{1}{2}}$ but can be scored without a value for A, i.e. for $\frac{A}{2}x^{-\frac{1}{2}}$	
(c)	M1 for some correct substitution of x = 9 in <u>their</u> expression for $f'(x)$ including an attempt at $(9)^{\pm\frac{k}{2}}$ (k odd) somewhere that leads to some appropriate multiples of $\frac{1}{3}$ or 3 A1 accept $\frac{15}{6}$ or any exact equivalent of 2.5 e.g. $\frac{45}{18},\frac{135}{54}$ or even $\frac{67.5}{27}$ <u>Misread (MR)</u> Only allow MR of the form $\frac{(3-k\sqrt{x})^2}{\sqrt{x}}$ N.B. Leads to answer in (c) of $\frac{k^2-1}{6}$ Score as M1A0A0, M1A1A1ft, M1A1ft	

Question Number	Scheme	Marks
Q10 (a)	$x(x^2-6x+9)$	B1
	$= x(x-3)(x-3)$	M1 A1 (3)
(b)	 Shape 	B1
	<u>Through</u> origin (<u>not</u> touching)	B1
	Touching x-axis only once	B1
	Touching at (3, 0), or 3 on x-axis	B1ft (4)
	[Must be on graph not in a table]	
(c)	 Moved horizontally (either way)	M1
	(2, 0) and (5, 0), or 2 and 5 on x-axis	A1 (2)
		[9]

(a) B1 for correctly taking out a factor of x

M1 for an attempt to factorize their 3TQ e.g. $(x+p)(x+q)$ where $|pq|=9$.

So $(x-3)(x+3)$ will score M1 but A0

A1 for a fully correct factorized expression - accept $x(x-3)^2$

If they "solve" use ISW

S.C. If the only correct linear factor is (x - 3), perhaps from factor theorem, award B0M1A0

Do not award marks for factorising in part (b)

<u>For the graphs</u>

"Sharp points" will lose the 1st B1 in (b) but otherwise be generous on shape

Condone (0, 3) in (b) and (0, 2), (0,5) in (c) if the points are marked in the correct places.

(b) 2nd B1 for a curve that starts or terminates at (0, 0) score B0

4th B1ft for a curve that touches (not crossing or terminating) at (a, 0) where their $y = x(x-a)^2$

(c) M1 for their graph moved horizontally (only) <u>or</u> a fully correct graph

Condone a partial stretch if ignoring their values looks like a simple translation

A1 for their graph translated 2 to the right <u>and</u> crossing or touching the axis at 2 and 5 only

Allow a fully correct graph (as shown above) to score M1A1 whatever they have in (b)

Question Number	Scheme	Marks
Q11 (a)	$x = 2$: $y = 8 - 8 - 2 + 9 = 7$ (*)	B1 (1)
(b)	$\frac{dy}{dx} = 3x^2 - 4x - 1$	M1 A1
	$x = 2$: $\frac{dy}{dx} = 12 - 8 - 1 (= 3)$	A1ft
	$y - 7 = 3(x - 2)$, $\underline{y = 3x + 1}$	M1, $\underline{\text{A1}}$ (5)
(c)	$m = -\frac{1}{3}$ (for $-\frac{1}{m}$ with their m)	B1ft
	$3x^2 - 4x - 1 = -\frac{1}{3}$, $9x^2 - 12x - 2 = 0$ or $x^2 - \frac{4}{3}x - \frac{2}{9} = 0$ (o.e.)	M1, A1
	$\left(x = \frac{12 + \sqrt{144 + 72}}{18}\right)\left(\sqrt{216} = \sqrt{36}\sqrt{6} = 6\sqrt{6}\right)$ or $(3x - 2)^2 = 6 \to 3x = 2 \pm \sqrt{6}$	M1
	$x = \frac{1}{3}\left(2 + \sqrt{6}\right)$ (*)	A1cso (5)
		[11]
(a)	B1 there must be a clear attempt to substitute $x = 2$ leading to 7 e.g. $2^3 - 2 \times 2^2 - 2 + 9 = 7$	
(b)	1st M1 for an attempt to differentiate with at least one of the given terms fully correct. 1st A1 for a fully correct expression 2nd A1ft for sub. x= 2 in <u>their</u> $\frac{dy}{dx}(\neq y)$ accept for a correct expression e.g. $3 \times (2)^2 - 4 \times 2 - 1$ 2nd M1 for use of their "3" (provided it comes from their $\frac{dy}{dx}(\neq y)$ and x=2) to find equation of tangent. Alternative is to use (2, 7) in $y = mx + c$ to <u>find a value</u> for c. Award when $c = \ldots$ is seen. **No attempted use of $\frac{dy}{dx}$ in (b) scores 0/5**	
(c) ALT	1st M1 for forming an equation from their $\frac{dy}{dx}(\neq y)$ and their $-\frac{1}{m}$ (must be changed from m) 1st A1 for a correct 3TQ all terms on LHS (condone missing =0) 2nd M1 for proceeding to $x =\ldots$ or $3x = \ldots$ by formula or completing the square for a 3TQ. Not factorising. Condone $\underline{+}$ 2nd A1 for proceeding to given answer with no incorrect working seen. Can still have $\underline{+}$. <u>Verify (for M1A1M1A1)</u> 1st M1 for attempting to square need $\geq$ 3 correct values in $\frac{4+6+4\sqrt{6}}{9}$, 1st A1 for $\frac{10+4\sqrt{6}}{9}$ 2nd M1 Dependent on 1st M1 in this case for substituting in all terms of their $\frac{dy}{dx}$ 2nd A1cso for cso <u>with a full comment</u> e.g. "the x co-ord of Q is ..."	