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Mark Scheme (Results)
January 2010

GCE

Core Mathematics C2 (6664)

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Question Number	Scheme	Marks
Q1	$\left[(3-x)^6 =\right] 3^6 + 3^5 \times 6 \times (-x) + 3^4 \times \binom{6}{2} \times (-x)^2$ $= 729, \quad -1458x, \quad +1215x^2$	M1 B1, A1, A1 [4]
Notes	**M1** for <u>either</u> the x term <u>or</u> the x^2 term. Requires <u>correct</u> binomial coefficient in any form with the correct power of x – condone lack of negative sign and wrong power of 3. This mark may be given if no working is shown, but one of the terms including x is correct. Allow $\frac{6}{1}$, or $\frac{6}{2}$ (must have a power of 3, even if only power 1) First term must be 729 for **B1**, (writing just 3^6 is **B0**) can isw if numbers added to this constant later. Can allow 729(1… Term must be simplified to $-1458x$ for **A1cao.** The x is required for this mark. **Final A1** is c.a.o and needs to be $+1215x^2$ (can follow omission of negative sign in working) Descending powers of x would be $x^6 + 3\times 6\times(-x)^5 + 3^2 \times \binom{6}{4} \times (-x)^4 + ..$ i.e. $x^6 - 18x^5 + 135x^4 + ..$ This is M1B1A0A0 if completely "correct" or M1 B0A0A0 for <u>correct</u> binomial coefficient in any form with the correct power of x as before	
Alternative	**NB Alternative method:** $(3-x)^6 = 3^6(1 + 6\times(-\frac{x}{3}) + \binom{6}{2} \times (-\frac{x}{3})^2 + ..)$ is **M1B0A0A0** – answers must be simplified to 729, $-1458x$, $+1215x^2$ for full marks (awarded as before) The mistake $(3-x)^6 = 3(1-\frac{x}{3})^6 = 3(1 + 6\times(-\frac{x}{3}) + \times\binom{6}{2} \times (-\frac{x}{3})^2 + ..)$ may also be awarded **M1B0A0A0** Another mistake $3^6(1 - 6x + 15x^2 ...) = 729...$ would be M1B1A0A0	

Question Number	Scheme	Marks
Q2 (a)	$5\sin x = 1 + 2\left(1 - \sin^2 x\right)$	M1
	$2\sin^2 x + 5\sin x - 3 = 0$ **(*)**	A1cso (2)
(b)	$(2s-1)(s+3) = 0$ **giving** s =	M1
	$\left[\sin x = -3 \text{ has no solution}\right]$ **so** $\sin x = \frac{1}{2}$	A1
	$\therefore \quad x = 30,\ 150$	B1, B1ft (4) [6]
(a)	M1 for a correct method to change $\cos^2 x$ into $\sin^2 x$ (must use $\cos^2 x = 1 - \sin^2 x$) A1 need 3 term quadratic printed in any order with =0 included	
(b)	M1 for attempt to solve given quadratic (usual rules for solving quadratics) (can use any variable here, *s*, *y*, *x*, or sin*x*) A1 requires no incorrect work seen and is for $\sin x = \frac{1}{2}$ **or** $x = \sin^{-1}\frac{1}{2}$ $y = \frac{1}{2}$ is A0 (unless followed by *x* = 30) B1 for 30 (α) not dependent on method 2nd B1 for 180 - α provided in required range (otherwise 540 - α) <u>Extra solutions outside required range</u>: Ignore <u>Extra solutions inside required range</u>: Lose final B1 <u>Answers in radians</u>: Lose final B1 S.C. Merely writes down two correct answers is M0A0B1B1 Or $\sin x = \frac{1}{2}$ $\therefore$ $x = 30,\ 150$ **is M1A1B1B1** Just gives one answer : 30 only is M0A0B1B0 or 150 only is M0A0B0B1 **NB** Common error is to factorise wrongly giving $(2\sin x + 1)(\sin x - 3) = 0$ $\left[\sin x = 3 \text{ gives no solution}\right]$ $\sin x = -\frac{1}{2}$ $\Rightarrow$ $x = 210,\ 330$ This earns M1 A0 B0 B1ft Another common error is to factorise correctly $(2\sin x - 1)(\sin x + 3) = 0$ and follow this with $\sin x = \frac{1}{2}$, $\sin x = 3$ then $x = 30^\circ, 150^\circ$ This would be M1 A0 B1 B1	

Question Number	Scheme	Marks
Q3 (a)	$\text{f}\left(\frac{1}{2}\right)=2\times\frac{1}{8}+a\times\frac{1}{4}+b\times\frac{1}{2}-6$	M1
	$\text{f}\left(\frac{1}{2}\right)=-5 \;\Rightarrow\; \frac{1}{4}a+\frac{1}{2}b=\frac{3}{4}$ or $a+2b=3$	A1
	$\text{f}(-2)=-16+4a-2b-6$	M1
	$\text{f}(-2)=0 \;\Rightarrow\; 4a-2b=22$	A1
	Eliminating one variable from 2 linear simultaneous equations in *a* and *b*	M1
	$a = 5$ and $b = -1$	A1 (6)
(b)	$2x^3+5x^2-x-6=(x+2)(2x^2+x-3)$	M1
	$=(x+2)(2x+3)(x-1)$	M1A1 (3)
	NB $(x+2)\left(x+\frac{3}{2}\right)(2x-2)$ is A0 But $2(x+2)\left(x+\frac{3}{2}\right)(x-1)$ is A1	[9]
(a)	1st M1 for attempting $\text{f}(\pm\frac{1}{2})$ Treat the omission of the –5 here as a slip and allow the M mark. 1st A1 for first correct equation in *a* and *b* simplified to three non zero terms (needs –5 used) s.c. If it is not simplified to three terms but is correct and is then used correctly with second equation to give correct answers- this mark can be awarded later. 2nd M1 for attempting $\text{f}(\mp 2)$ 2nd A1 for the second correct equation in *a* and *b*. simplified to three terms (needs 0 used) s.c. If it is not simplified to three terms but is correct and is then used correctly with first equation to give correct answers - this mark can be awarded later. 3rd M1 for an attempt to eliminate one variable from 2 linear simultaneous equations in *a* and *b* 3rd A1 for both $a = 5$ and $b = -1$ (Correct answers here imply previous two A marks)	
(b)	1st M1 for attempt to divide by (x+2) leading to a 3TQ beginning with correct term usually $2x^2$ 2nd M1 for attempt to factorize their quadratic provided no remainder A1 is cao and needs all three factors Ignore following work (such as a solution to a quadratic equation).	
(a)	<u>Alternative;</u> M1 for dividing by $(2x-1)$, to get $x^2+(\frac{a+1}{2})x+\text{constant}$ **with remainder as a function of *a* and *b***, and A1 as before for equations stated in scheme . M1 for dividing by $(x+2)$, to get $2x^2+(a-4)x...$ (No need to see remainder as it is zero and comparison of coefficients may be used) with A1 as before	
(b)	<u>Alternative;</u> M1 for finding second factor correctly by factor theorem, usually $(x - 1)$ M1 for using two known factors to find third factor , usually $(2x\pm 3)$ Then A1 for correct factorisation written as product $(x+2)(2x+3)(x-1)$	

<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td>Q4
(a)</td><td>

Either $\frac{\sin(A\hat{C}B)}{5} = \frac{\sin 0.6}{4}$
$\therefore\ A\hat{C}B = \arcsin(0.7058...)$
$= [0.7835.. \text{ or } 2.358]$
Use angles of triangle
$A\hat{B}C = \pi - 0.6 - A\hat{C}B$
(But as AC is the longest side so)
$A\hat{B}C = 1.76$ (*)(3sf) [Allow $100.7° \to 1.76$]
In degrees $0.6 = 34.377°$, $\text{A}\hat{\text{C}}\text{B} = 44.9°$

or $4^2 = b^2 + 5^2 - 2 \times b \times 5\cos 0.6$
$\therefore b = \frac{10\cos 0.6 \pm \sqrt{(100\cos^2 0.6 - 36)}}{2}$
$= [6.96 \text{ or } 1.29]$
Use sine / cosine rule with value for b
$\sin B = \frac{\sin 0.6}{4} \times b$ or $\cos B = \frac{25 + 16 - b^2}{40}$
(But as AC is the longest side so)
$A\hat{B}C = 1.76$ (*)(3sf)

</td><td>M1
M1
M1,
A1
(4)</td></tr>
<tr><td>(b)</td><td>

$\left|C\hat{B}D = \pi - 1.76 = 1.38\right|$ Sector area = $\frac{1}{2} \times 4^2 \times (\pi - 1.76) = [11.0 \sim 11.1]$ $\frac{1}{2} \times 4^2 \times 79.3$ is M0
Area of $\Delta ABC = \frac{1}{2} \times 5 \times 4 \times \sin(1.76) = [9.8]$ or $\frac{1}{2} \times 5 \times 4 \times \sin 101$
Required area = awrt 20.8 or 20.9 or 21.0 or gives 21 (2sf) after correct work.

</td><td>M1
M1
A1 (3)
[7]</td></tr>
<tr><td>(a)</td><td colspan="2">

1st M1 for correct use of sine rule to find ACB or cosine rule to find b (M0 for ABC here or for use of sin x where x could be ABC)
2nd M1 for a correct expression for angle ACB (This mark may be implied by .7835 or by arcsin (.7058)) and needs accuracy. In second method this M1 is for correct expression for b – may be implied by 6.96. [Note $10\cos 0.6 \approx 8.3$] (do not need two answers)
3rd M1 for a correct method to get angle ABC in method (i) or sinABC or cosABC , in method (ii) (If sin B >1, can have M1A0)
A1cso for correct work leading to 1.76 3sf . Do not need to see angle 0.1835 considered and rejected.

</td></tr>
<tr><td>(b)</td><td colspan="2">

1st M1 for a correct expression for sector area or a value in the range 11.0 – 11.1
2nd M1 for a correct expression for the area of the triangle or a value of 9.8
Ignore 0.31 (working in degrees) as subsequent work.
A1 for answers which round to 20.8 or 20.9 or 21.0. No need to see units.

</td></tr>
<tr><td>(a)</td><td colspan="2">

Special case If answer 1.76 is assumed then usual mark is M0 M0 M0 A0. A Fully checked method may be worth M1 M1 M0 A0. A maximum of 2 marks. The mark is either 2 or 0.
Either **M1** for $A\hat{C}B$ is found to be 0,7816 (angles of triangle) then
M1 for checking $\frac{\sin(A\hat{C}B)}{5} = \frac{\sin 0.6}{4}$ with conclusion giving numerical answers
This gives a maximum mark of 2/4
OR **M1** for b is found to be 6.97 (cosine rule)
M1 for checking $\frac{\sin(ABC)}{b} = \frac{\sin 0.6}{4}$ with conclusion giving numerical answers
This gives a maximum mark of 2/4
Candidates making this assumption need a complete method. They cannot earn M1M0.
So the score will be 0 or 2 for part (a). Circular arguments earn 0/4.

</td></tr>
</table>

Question Number	Scheme	Marks
Q5 (a)	$\log_x 64 = 2 \quad \Rightarrow \quad 64 = x^2$	M1
	So $x = 8$	A1 (2)
(b)	$\log_2(11-6x) = \log_2(x-1)^2 + 3$	M1
	$\log_2\left[\dfrac{11-6x}{(x-1)^2}\right] = 3$	M1
	$\dfrac{11-6x}{(x-1)^2} = 2^3$	M1
	$\{11-6x = 8(x^2-2x+1)\}$ and so $0 = 8x^2 - 10x - 3$	A1
	$0 = (4x+1)(2x-3) \quad \Rightarrow x = ...$	dM1
	$x = \dfrac{3}{2}, \left[-\dfrac{1}{4}\right]$	A1 (6)
		[8]
(a)	M1 for getting out of logs A1 Do not need to see x = -8 appear and get rejected. Ignore x = -8 as extra solution. x= 8 with no working is M1 A1	
(b)	1st M1 for using the $n\log x$ rule 2nd M1 for using the $\log x$ - $\log y$ rule or the $\log x + \log y$ rule as appropriate 3rd M1 for using 2 to the power– need to see 2^3 or 8 (May see $3 = \log_2 8$ used) **If all three M marks have been earned and logs are still present** in equation **do not give** final M1. So solution stopping at $\log_2\left[\dfrac{11-6x}{(x-1)^2}\right] = \log_2 8$ would earn M1M1M0 1st A1 for a correct 3TQ 4th dependent M1 for attempt to solve or factorize their 3TQ to obtain x =… (mark depends on three previous M marks) 2nd A1 for 1.5 (ignore -0.25) s.c 1.5 only – no working – is 0 marks	
(a)	<u>Alternatives</u> Change base : (i) $\dfrac{\log_2 64}{\log_2 x} = 2$, so $\log_2 x = 3$ and $x = 2^3$, is M1 or (ii) $\dfrac{\log_{10} 64}{\log_{10} x} = 2$, $\log x = \frac{1}{2}\log 64$ so $x = 64^{\frac{1}{2}}$ is M1 then x = 8 is A1 **BUT** $\log x = 0.903$ so x = 8 is M1A0 (loses accuracy mark) (iii) $\log_{64} x = \frac{1}{2}$ so $x = 64^{\frac{1}{2}}$ is M1 then x = 8 is A1	

Question Number	Scheme	Marks
Q6 (a)	$18000\times(0.8)^3 \quad = £9216\ *$ [may see $\frac{4}{5}$ or 80% or equivalent].	B1cso (1)
(b)	$18000\times(0.8)^n < 1000$	M1
	$n\log(0.8) < \log\left(\frac{1}{18}\right)$	M1
	$n > \dfrac{\log\left(\frac{1}{18}\right)}{\log(0.8)} = 12.952....$ so $n = 13$.	A1 cso (3)
(c)	$u_5 = 200\times(1.12)^4$, $= £314.70$ or $£314.71$	M1, A1 (2)
(d)	$S_{15} = \dfrac{200\left(1.12^{15}-1\right)}{1.12-1}$ or $\dfrac{200\left(1-1.12^{15}\right)}{1-1.12}$, = 7455.94….. awrt £7460	M1A1, A1 (3) [9]
(a)	B1 NB Answer is printed **so need working**. May see as above or ×0.8 in three steps giving 14400, 11520, 9216. Do not need to see £ sign but should see 9216 .	
(b)	1st M1 for an attempt to use *n*th term and 1000. Allow *n* or *n* – 1 and allow > or = 2nd M1 for use of logs to find *n* Allow *n* or *n* – 1 and allow > or = A1 Need *n* = 13 This is an accuracy mark and must follow award of both M marks but should not follow incorrect work using *n* – 1 for example. Condone slips in inequality signs here.	
(c)	M1 for use of their *a* and *r* in formula for 5th term of GP A1 cao need one of these answers – answer can imply method here NB 314.7 – A0	
(d)	M1 for use of sum to 15 terms of GP using their *a* and their *r* (allow if formula stated correctly and one error in substitution, but must use *n* not *n* - 1) 1st A1 for a fully correct expression (not evaluated)	
(b)	Alternative Methods Trial and Improvement See 989.56 (or 989 or 990) identified with 12, 13 or 14 years for **first M1** See 1236.95 (or 1236 or 1237) identified with 11, 12 or 13 years for second **M1** Then *n* = 13 is **A1 (needs both Ms)** **Special case** $18000\times(0.8)^n < 1000$ so *n* = 13 as 989.56<1000 is M1M0A0 (not discounted *n* = 12)	
(c)	May see the terms 224, 250.88, 280.99, 314.71 with a small slip for M1 A0, or done accurately for M1A1	
(d)	Adds 15 terms 200 + 224 + 250.88+… + (977.42) **M1** Seeing 977… is **A1** Obtains answer 7455.94 **A1** or awrt £7460 NOT 7450	

Question Number	Scheme	Marks
Q7 (a)	**Puts** $y = 0$ and attempts to solve quadratic e.g. $(x-4)(x-1)=0$ Points are (1,0) and (4, 0)	M1 A1 (2)
(b)	$x = 5$ gives $y = 25 - 25 + 4$ and so (5, 4) lies on the curve	B1cso (1)
(c)	$\int(x^2-5x+4)\,dx = \frac{1}{3}x^3 - \frac{5}{2}x^2 + 4x \quad (+c)$	M1A1 (2)
(d)	Area of triangle = $\frac{1}{2}\times4\times4=8$ or $\int(x-1)\,dx = \frac{1}{2}x^2 - x$ with limits 1 and 5 to give 8	B1
	Area under the curve = $\int_4^5$ $\quad \frac{1}{3}\times5^3 - \frac{5}{2}\times5^2+4\times5 \quad \left[=-\frac{5}{6}\right]$	M1
	$\frac{1}{3}\times4^3 - \frac{5}{2}\times4^2+4\times4 \quad \left[=-\frac{8}{3}\right]$	M1
	$\int_4^5 = -\frac{5}{6} - -\frac{8}{3} = \frac{11}{6}$ or equivalent (allow 1.83 or 1.8 here)	A1 cao
	Area of R = $8-\frac{11}{6}=6\frac{1}{6}$ or $\frac{37}{6}$ or $6.1\dot{6}$ (not 6.17)	A1 cao (5)
		[10]
(a)	M1 for attempt to find L and M A1 Accept $x = 1$ and $x = 4$, then isw or accept L =(1,0) , M = (4,0) Do not accept L = 1, M = 4 nor (0 , 1), (0 , 4) (unless subsequent work) Do not need to distinguish L and M. Answers imply M1A1.	
(b)	See substitution, working should be shown, need conclusion which could be just y = 4 or a tick. Allow y = 25 - 25 + 4 = 4 But not 25 - 25 + 4 = 4. ($y=4$ may appear at start) Usually 0 = 0 or 4 = 4 is B0	
(c)	M1 for attempt to integrate $x^2 \to kx^3, x \to kx^2$ or $4 \to 4x$ A1 for correct integration of all three terms (do not need constant) isw. Mark correct work when seen. So e.g. $\frac{1}{3}x^3 - \frac{5}{2}x^2 + 4x$ is A1 then $2x^3 - 15x^2 + 24x$ would be ignored as subsequent work.	
(d)	B1 for this triangle only (not triangle LMN) 1st M1 for substituting 5 into their changed function 2nd M1 for substituting 4 into their changed function	
(d)	Alternative method: $\int_1^5 (x-1)-(x^2-5x+4)dx + \int_1^4 x^2-5x+4dx$ can lead to correct answer Constructs $\int_1^5 (x-1)-(x^2-5x+4)dx$ is B1 M1 for substituting 5 and 1 and subtracting in first integral M1 for substituting 4 and 1 and subtracting in second integral A1 for answer to first integral i.e. $\frac{32}{3}$ (allow 10.7) and A1 for final answer as before..	

(d)	Another alternative $\int_4^5 (x-1)-(x^2-5x+4)\mathrm{d}x +$ *area of triangle LMP* Constructs $\int_4^5 (x-1)-(x^2-5x+4)\mathrm{d}x$ is B1 M1 for substituting 5 and 4 and subtracting in first integral M1 for complete method to find area of triangle (4.5) A1 for answer to first integral i.e. $\frac{5}{3}$ and A1 for final answer as before.
(d)	Could also use $\int_4^5 (4x-16)-(x^2-5x+4)\mathrm{d}x +$ *area of triangle LMN* Similar scheme to previous one. Triangle has area 6 A1 for finding Integral has value $\frac{1}{6}$ and A1 for final answer as before.

Question Number	Scheme	Marks
Q8 (a)	$N\,(2, -1)$	B1, B1 (2)
(b)	$r = \sqrt{\dfrac{169}{4}} = \dfrac{13}{2} = 6.5$	B1 (1)
(c)	Complete Method to find x coordinates, $x_2 - x_1 = 12$ and $\dfrac{x_1 + x_2}{2} = 2$ then solve	M1
	To obtain $x_1 = -4$, $x_2 = 8$	A1ft A1ft
	Complete Method to find y coordinates, using equation of circle or Pythagoras i.e. let d be the distance below N of A *then* $d^2 = 6.5^2 - 6^2 \Rightarrow d = 2.5 \Rightarrow y = ..$	M1
	So $y_2 = y_1 = -3.5$	A1 (5)
(d)	Let $A\hat{N}B = 2\theta \Rightarrow \sin\theta = \dfrac{6}{"6.5"} \Rightarrow \theta = (67.38)...$	M1
	So angle ANB is 134.8 *	A1 (2)
(e)	AP is perpendicular to AN so using triangle ANP $\tan\theta = \dfrac{AP}{"6.5"}$	M1
	Therefore $AP = 15.6$	A1cao (2)
		[12]
(a) (b)	B1 for 2 (α) , B1 for -1 B1 for 6.5 o.e.	
(c)	1st M1 for finding x coordinates – may be awarded if either x co-ord is correct A1ft,A1ft are for $\alpha - 6$ and $\alpha + 6$ if x coordinate of N is α 2nd M1 for a method to find y coordinates – may be given if y co-ordinate is correct A marks is for -3.5 only.	
(d)	M1 for a full method to find θ or angle ANB (eg sine rule or cosine rule directly or finding another angle and using angles of triangle.) **ft their 6.5 from radius or wrong *y*.** (cos ANB = $\dfrac{"6.5"^2 + "6.5"^2 - 12^2}{2 \times "6.5" \times "6.5"}$ =-0.704) A1 is a printed answer and must be 134.8 – do not accept 134.76.	
(e)	M1 for a full method to find AP Alternative Methods N.B. May use triangle AXP where X is the mid point of AB. Or may use triangle ABP. From circle theorems may use angle BAP = 67.38 or some variation. Eg $\dfrac{AP}{\sin 67.4} = \dfrac{12}{\sin 45.2}$, $AP = \dfrac{6}{\sin 22.6}$ or $AP = \dfrac{6}{\cos 67.4}$ are each worth M1	

Question Number	Scheme	Marks
Q9 (a)	$\left[y = 12x^{\frac{1}{2}} - x^{\frac{3}{2}} - 10 \right]$	
	$[y' =] \quad 6x^{-\frac{1}{2}} - \frac{3}{2}x^{\frac{1}{2}}$	M1 A1
	Puts their $\frac{6}{x^{\frac{1}{2}}} - \frac{3}{2}x^{\frac{1}{2}} = 0$	M1
	So $x = \quad , \frac{12}{3} = 4$ (If $x = 0$ appears also as solution then lose A1)	M1, A1
	$x = 4, \quad \Rightarrow \quad y = 12 \times 2 - 4^{\frac{3}{2}} - 10$, so $y = 6$	dM1, A1 (7)
(b)	$y'' = -3x^{-\frac{3}{2}} - \frac{3}{4}x^{-\frac{1}{2}}$	M1A1 (2)
(c)	[Since x >0] It is a maximum	B1 (1) [10]
(a)	1st M1 for an attempt to differentiate a fractional power $x^n \to x^{n-1}$ A1 a.e.f – can be unsimplified 2nd M1 for forming a suitable equation using their y'=0 3rd M1 for correct processing of fractional powers leading to x = … (Can be implied by x = 4) A1 is for x = 4 only. If x = 0 also seen and not discarded they lose this mark only. 4th M1 for substituting their value of x back into y to find y value. Dependent on three previous M marks. Must see evidence of the substitution with attempt at fractional powers to give M1A0, but y = 6 can imply M1A1	
(b)	M1 for differentiating their y' again A1 should be simplified	
(c)	B1 . Clear conclusion needed and must follow correct y'' It is dependent on previous A mark (Do not need to have found x earlier). (Treat parts (a),(b) and (c) together for award of marks)	

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