Centre No.						Paper Reference	Surname	Initial(s)
Candidate No.						6 6 6 4 / 0 1	Signature	

Paper Reference(s)

6664/01

Edexcel GCE

Core Mathematics C2

Advanced Subsidiary

Monday 20 June 2005 – Morning

Time: 1 hour 30 minutes

Materials required for examination	Items included with question papers
Mathematical Formulae (Green)	Nil

Candidates may use any calculator EXCEPT those with the facility for symbolic algebra, differentiation and/or integration. Thus candidates may NOT use calculators such as the Texas Instruments TI 89, TI 92, Casio CFX 9970G, Hewlett Packard HP 48G.

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initials and signature.
Check that you have the correct question paper.
You must write your answer for each question in the space following the question.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 10 questions in this question paper. The total mark for this paper is 75.
There are 28 pages in this question paper. Any blank pages are indicated.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

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1. Find the coordinates of the stationary point on the curve with equation $y = 2x^2 - 12x$.

(4)

Q1

(Total 4 marks)

June 2005
6664 Core Mathematics C2
Mark Scheme

Question number	Scheme	Marks
1.	$\frac{dy}{dx} = 4x - 12$ $4x - 12 = 0 \quad x = 3$ $y = -18$	B1 M1 A1ft A1 (4) **4**
	M1: Equate $\frac{dy}{dx}$ (not just y) to zero and proceed to $x = \ldots$ A1ft: Follow through only from a linear equation in x. <u>Alternative:</u> $y = 2x(x-6) \Rightarrow$ Curve crosses x-axis at 0 and 6 — B1 (By symmetry) $x = 3$ — M1 A1ft $y = -18$ — A1 <u>Alternative:</u> $(x-3)^2$ — B1 for $(x-3)^2$ seen somewhere $y = 2(x^2 - 6x) = 2\{(x-3)^2 - 9\}$ $\quad x = 3$ M1 for attempt to complete square and deduce $x = \ldots$ A1ft [$(x-a)^2 \Rightarrow x = a$] $y = -18$ — A1	

Leave blank

2. Solve

(a) $5^x = 8$, giving your answer to 3 significant figures,

(3)

(b) $\log_2(x + 1) - \log_2 x = \log_2 7$.

(3)

Question number	Scheme	Marks
2.	(a) $x\log 5 = \log 8$, $x = \frac{\log 8}{\log 5}$, = 1.29	M1, A1, A1 (3)
	(b) $\log_2 \frac{x+1}{x}$ (or $\log_2 7x$)	B1
	$\frac{x+1}{x} = 7$ $x = \ldots$, $\frac{1}{6}$ (Allow 0.167 or better)	M1, A1 (3)
		6
	(a) Answer only 1.29 : Full marks. Answer only, which rounds to 1.29 (e.g. 1.292): M1 A1 A0 Answer only, which rounds to 1.3 : M1 A0 A0 Trial and improvement: Award marks as for "answer only". (b) M1: Form (by legitimate log work) and solve an equation in *x*. Answer only: No marks unless verified (then full marks are available).	

Leave blank

3. (a) Use the factor theorem to show that $(x + 4)$ is a factor of $2x^3 + x^2 - 25x + 12$.

(2)

(b) Factorise $2x^3 + x^2 - 25x + 12$ completely.

(4)

Question number	Scheme	Marks
3.	(a) Attempt to evaluate f(–4) or f(4)	M1
	$f(-4) = 2(-4)^3 + (-4)^2 - 25(-4) + 12 \quad (= 128 + 16 + 100 + 12) \; = 0$, so ….. is a factor.	A1 (2)
	(b) $(x+4)(2x^2 - 7x + 3)$	M1 A1
	……...$(2x-1)(x-3)$	M1 A1 (4)
		6
	(b) First M requires $(2x^2 + ax + b), \; a \neq 0, b \neq 0$. Second M for the attempt to factorise the quadratic. <u>Alternative:</u> $(x+4)(2x^2 + ax + b) = 2x^3 + (8+a)x^2 + (4a+b)x + 4b = 0$, then compare coefficients to find <u>values</u> of a and b. [M1] $a = -7, \; b = 3$ [A1] <u>Alternative:</u> Factor theorem: Finding that $f\left(\frac{1}{2}\right) = 0, \therefore (2x-1)$ is a factor [M1, A1] n.b. Finding that $f\left(\frac{1}{2}\right) = 0, \therefore (x - \frac{1}{2})$ is a factor scores M1, A0 ,unless the factor 2 subsequently appears. Finding that $f(3) = 0, \therefore (x-3)$ is a factor [M1, A1]	

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4. (a) Write down the first three terms, in ascending powers of x, of the binomial expansion of $(1 + px)^{12}$, where p is a non-zero constant.

(2)

Given that, in the expansion of $(1 + px)^{12}$, the coefficient of x is $(-q)$ and the coefficient of x^2 is $11q$,

(b) find the value of p and the value of q.

(4)

Question number	Scheme	Marks
4.	(a) $1+12px,\ +\dfrac{12\times 11}{2}(px)^2$	B1, B1 (2)
	(b) $12p(x) = -q(x)$ $\quad 66p^2(x^2) = 11q(x^2)$ (Equate terms, or coefficients)	M1
	$\Rightarrow \quad 66p^2 = -132p$ (Eqn. in p or q only)	M1
	$p = -2, \quad q = 24$	A1, A1 (4)
		6
	(a) Terms can be listed rather than added. First B1: Simplified form must be seen, but may be in (b). (b) First M: May still have $\binom{12}{2}$ or ${}^{12}C_2$ Second M: <u>Not</u> with $\binom{12}{2}$ or ${}^{12}C_2$. Dependent upon having p's in each term. Zero solutions must be rejected for the final A mark.	

Leave blank

5. Solve, for $0 \leqslant x \leqslant 180°$, the equation

(a) $\sin(x + 10°) = \dfrac{\sqrt{3}}{2}$,

(4)

(b) $\cos 2x = -0.9$, giving your answers to 1 decimal place.

(4)

Question number	Scheme	Marks
5.	(a) $(x+10=)$ 60 α	B1
	120 (M: $180-\alpha$ or $\pi-\alpha$)	M1
	$x = 50$ $x = 110$ (or 50.0 and 110.0) (M: Subtract 10)	M1 A1 (4)
	(b) $(2x=)$ 154.2 β Allow a.w.r.t. 154 or a.w.r.t. 2.69 (radians)	B1
	205.8 (M: $360-\beta$ or $2\pi-\beta$)	M1
	$x = 77.1$ $x = 102.9$ (M: Divide by 2)	M1 A1 (4)
		8
	(a) First M: Must be subtracting from 180 <u>before</u> subtracting 10. (b) First M: Must be subtracting from 360 <u>before</u> dividing by 2, <u>or</u> dividing by 2 then subtracting from 180. In each part: Extra solutions outside 0 to 180 : Ignore. Extra solutions between 0 and 180 : A0. <u>Alternative for (b): (double angle formula)</u> $1-2\sin^2 x = -0.9$ $2\sin^2 x = 1.9$ B1 $\sin x = \sqrt{0.95}$ M1 $x = 77.1$ $x = 180-77.1 = 102.9$ M1 A1	

Leave blank

6. A river, running between parallel banks, is 20 m wide. The depth, y metres, of the river measured at a point x metres from one bank is given by the formula

$$y = \frac{1}{10}x\sqrt{(20 - x)}, \quad 0 \leqslant x \leqslant 20.$$

(a) Complete the table below, giving values of y to 3 decimal places.

x	0	4	8	12	16	20
y	0		2.771			0

(2)

(b) Use the trapezium rule with all the values in the table to estimate the cross-sectional area of the river.

(4)

Given that the cross-sectional area is constant and that the river is flowing uniformly at 2 ms^{-1},

(c) estimate, in m^3, the volume of water flowing per minute, giving your answer to 3 significant figures.

(2)

Question number	Scheme	Marks
6.	(a) Missing y values: 1.6(00) 3.2(00) 3.394	B1 B1 (2)
	(b) $(A =)\ \frac{1}{2} \times 4,\ \{(0+0) + 2(1.6 + 2.771 + 3.394 + 3.2)\}$	B1, M1 A1ft
	= 43.86 (or a more accurate value) (or 43.9, or 44)	A1 (4)
	(c) Volume = $A \times 2 \times 60$	M1
	= 5260 (m^3) (or 5270, or 5280)	A1 (2)
		8
	(b) Answer only: No marks. (c) Answer only: Allow. (The M mark in this part can be "implied").	

Leave blank

7. In the triangle ABC, $AB = 8$ cm, $AC = 7$ cm, $\angle ABC = 0.5$ radians and $\angle ACB = x$ radians.

(a) Use the sine rule to find the value of $\sin x$, giving your answer to 3 decimal places. **(3)**

Given that there are two possible values of x,

(b) find these values of x, giving your answers to 2 decimal places. **(3)**

Question number	Scheme	Marks
7.	(a) $\frac{\sin x}{8} = \frac{\sin 0.5}{7}$ or $\frac{8}{\sin x} = \frac{7}{\sin 0.5}$, $\sin x = \frac{8 \sin 0.5}{7}$	M1 A1ft
	$\sin x = 0.548$	A1 (3)
	(b) $x = 0.58$ (α) (This mark may be earned in (a)).	B1
	$\pi - \alpha = 2.56$	M1 A1ft (3)
		6
	(a) M: Sine rule attempt (sides/angles possibly the "wrong way round"). A1ft: follow through from sides/angles are the "wrong way round". <u>Too many d.p. given:</u> Maximum 1 mark penalty in the complete question. (Deduct on first occurrence).	

Leave blank

8. The circle C, with centre at the point A, has equation $x^2 + y^2 - 10x + 9 = 0$.

Find

(a) the coordinates of A,

(2)

(b) the radius of C,

(2)

(c) the coordinates of the points at which C crosses the x-axis.

(2)

Given that the line l with gradient $\frac{7}{2}$ is a tangent to C, and that l touches C at the point T,

(d) find an equation of the line which passes through A and T.

(3)

Question number	Scheme	Marks	
8.	(a) Centre (5, 0) (or $x = 5$, $y = 0$)	B1 B1	(2)
	(b) $(x \pm a)^2 \pm b \pm 9 + (y \pm c)^2 = 0 \Rightarrow r^2 = \ldots$ or $r = \ldots$, Radius = 4	M1, A1	(2)
	(c) (1, 0), (9, 0) Allow just $x = 1$, $x = 9$	B1ft, B1ft	(2)
	(d) Gradient of $AT = -\frac{2}{7}$	B1	
	$y = -\frac{2}{7}(x-5)$	M1 A1ft	(3)
			9
	(a) (0, 5) scores B1 B0. (d) M1: Equation of straight line through centre, <u>any</u> gradient (except 0 or ∞) (The equation can be in any form). A1ft: Follow through from centre, but gradient must be $-\frac{2}{7}$.		

Leave blank

9. (a) A geometric series has first term a and common ratio r. Prove that the sum of the first n terms of the series is

$$\frac{a(1-r^n)}{1-r}.$$

(4)

Mr. King will be paid a salary of £35 000 in the year 2005. Mr. King's contract promises a 4% increase in salary every year, the first increase being given in 2006, so that his annual salaries form a geometric sequence.

(b) Find, to the nearest £100, Mr. King's salary in the year 2008.

(2)

Mr. King will receive a salary each year from 2005 until he retires at the end of 2024.

(c) Find, to the nearest £1000, the total amount of salary he will receive in the period from 2005 until he retires at the end of 2024.

(4)

Question number	Scheme	Marks
9.	(a) $(S=)\ a+ar+...+ar^{n-1}$ "$S=$" not required. Addition required.	B1
	$(rS=)\ ar+ar^2+...+ar^n$ "$rS=$" not required (M: Multiply by r)	M1
	$S(1-r)=a(1-r^n)$ $S=\dfrac{a(1-r^n)}{1-r}$ (M: Subtract and factorise) (*)	M1 A1cso (4)
	(b) $ar^{n-1}=35000\times1.04^3=39400$ (M: Correct a and r, with n = 3, 4 or 5).	M1 A1 (2)
	(c) n = 20 (Seen or implied)	B1
	$S_{20}=\dfrac{35000(1-1.04^{20})}{(1-1.04)}$	M1 A1ft
	(M1: Needs <u>any</u> r value, a = 35000, n =19, 20 or 21).	
	(A1ft: ft from n =19 or n =21, but r must be 1.04).	
	= 1 042 000	A1 (4)
		10
	(a) B1: At least the 3 terms shown above, and no extra terms. A1: Requires a completely correct solution. <u>Alternative for the 2 M marks</u>: M1: Multiply numerator and denominator by 1 – r. M1: Multiply out numerator convincingly, and factorise. (b) M1 can also be scored by a "year by year" method. <u>Answer only:</u> 39 400 scores full marks, 39 370 scores M1 A0. (c) M1 can also be scored by a "year by year" method, <u>with terms added</u>. In this case the B1 will be scored if the correct number of years is considered. <u>Answer only:</u> Special case: 1 042 000 scores 2 B marks, scored as 1, 0, 0, 1 (Other answers score no marks). <u>Failure to round correctly in (b) and (c):</u> Penalise once only (first occurrence).	

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10. **Figure 1**

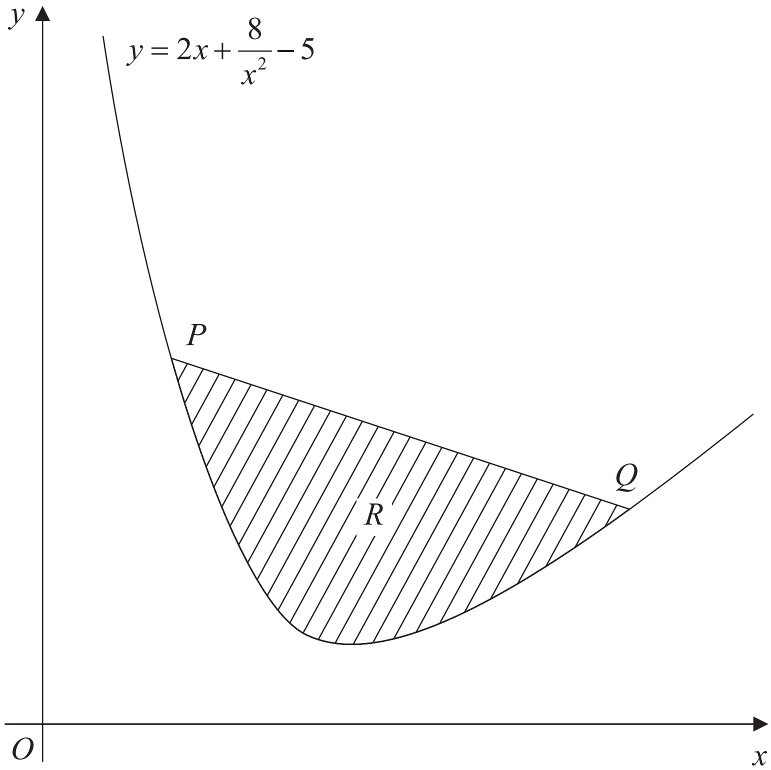

Figure 1 shows part of the curve C with equation $y = 2x + \frac{8}{x^2} - 5$, $x > 0$.

The points P and Q lie on C and have x-coordinates 1 and 4 respectively. The region R, shaded in Figure 1, is bounded by C and the straight line joining P and Q.

(a) Find the exact area of R.

(8)

(b) Use calculus to show that y is increasing for $x > 2$.

(4)

Question number	Scheme	Marks
10.	(a) $\int(2x+8x^{-2}-5)\mathrm{d}x = x^2+\frac{8x^{-1}}{-1}-5x$	M1 A1 A1
	$\left[x^2+\frac{8x^{-1}}{-1}-5x\right]_1^4 = (16-2-20)-(1-8-5)$ (= 6)	M1
	$x=1$: $y=5$ and $x=4$: $y=3.5$	B1
	Area of trapezium = $\frac{1}{2}(5+3.5)(4-1)$ $(=12.75)$	M1
	Shaded area = 12.75 – 6 = 6.75 (M: Subtract either way round)	M1 A1 (8)
	(b) $\frac{\mathrm{d}y}{\mathrm{d}x} = 2-16x^{-3}$	M1 A1
	(Increasing where) $\frac{\mathrm{d}y}{\mathrm{d}x} > 0$; For $x>2$, $\frac{16}{x^3}<2$, $\therefore \frac{\mathrm{d}y}{\mathrm{d}x}>0$ (Allow ≥)	dM1; A1 (4)
		12
	(a) Integration: One term wrong M1 A1 A0; two terms wrong M1 A0 A0. Limits: M1 for substituting limits 4 and 1 into a changed function, and subtracting the right way round.	
	<u>Alternative:</u>	
	$x=1$: $y=5$ and $x=4$: $y=3.5$	B1
	Equation of line: $y-5=-\frac{1}{2}(x-1)$ $y=\frac{11}{2}-\frac{1}{2}x$, subsequently used in integration with limits.	3rd M1
	$\left(\frac{11}{2}-\frac{1}{2}x\right)-\left(2x+\frac{8}{x^2}-5\right)$ (M: Subtract either way round)	4th M1
	$\int\left(\frac{21}{2}-\frac{5x}{2}-8x^{-2}\right)\mathrm{d}x = \frac{21x}{2}-\frac{5x^2}{4}-\frac{8x^{-1}}{-1}$ (Penalise integration mistakes, not algebra for the ft marks)	1st M1 A1ft A1ft
	$\left[\frac{21x}{2}-\frac{5x^2}{4}-\frac{8x^{-1}}{-1}\right]_1^4 = (42-20+2)-\left(\frac{21}{2}-\frac{5}{4}+8\right)$ (M: Right way round)	2nd M1
	Shaded area = 6.75	A1
	(The follow through marks are for the subtracted version, and again deduct an accuracy mark for a wrong term: One wrong M1 A1 A0; two wrong M1 A0 A0.)	
	<u>Alternative for the last 2 marks in (b):</u> M1: Show that $x=2$ is a minimum, using, e.g., 2nd derivative. A1: Conclusion showing understanding of “increasing”, with accurate working.	