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Examiners' Report/ Principal Examiner Feedback

Summer 2010

GCE

Core Mathematics C4 (6666)

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Introduction

The level of difficulty of this paper was similar to others in recent Summer examinations. The majority of candidates were able to score well in Q1, Q2, Q3, Q4 and Q5(a). The vector question was more accessible than some that have been set in recent years. Q5(b), Q6 and Q8 proved more challenging but, even in these questions, fully correct solutions were not uncommon.

In general the standard of presentation was acceptable but these papers are marked online and if a pencil is used to draw diagrams, then the pencil needs to be sufficiently soft to show up. A good quality HB pencil shows up well. It should also be noted that coloured inks do not show up well and may even be invisible.

The standard of algebraic manipulation is of some concern. Brackets are often omitted and this can lead to a loss of marks. For example, writing the approximate integral in Q1(b)(ii) as $\frac{h}{2}y_0 + y_4 + 2\left(y_1 + y_2 + y_3\right)$ can lead to a failure to multiply $2\left(y_1 + y_2 + y_3\right)$ by $\frac{h}{2}$. Elementary errors of algebraic manipulation were often seen in Q8 when candidates attempted separate variables. For example, errors such as $75\frac{\mathrm{d}h}{\mathrm{d}t} = 4 - 5h$ rearranged as $\int \frac{1}{-5h}\,\mathrm{d}h = \int \frac{4}{75}\,\mathrm{d}t$ were seen and even correct rearrangements were sometimes followed by errors such as $\frac{1}{4-5h} = \frac{1}{4} - \frac{1}{5h}$.

Not all candidates were able to make substantial attempts at the last question. This was a demanding question and possibly there were some candidates who were unable to tackle it. Many, however, had used up a great deal of time in long, and often fruitless, attempts to solve earlier questions, and were unable to give sufficient time to the last question. As noted below, unnecessarily long attempts were often seen in Q2 and Q7.

In general, the use of calculators was appropriate and almost all candidates now recognise that, when a question asks for an exact answer, a decimal approximation is not acceptable.

Report on individual questions

Question 1

This question was a good starting question and over 60% of the candidates gained full marks. A few candidates used a wrong angle mode when calculating the values in part (a). In part (b), the majority knew the structure of the trapezium rule. The most common errors were to miscalculate the interval width using, for example, $\frac{\pi}{9}$ and $\frac{\pi}{15}$ in place of $\frac{\pi}{12}$ and $\frac{\pi}{24}$. Some were unable to adapt to the situation in which they did not need all the information given in the question to solve part of it and either used the same interval width for (b)(i) and (b)(ii) or answered b(ii) only. A few answered b(ii) only and proceeded to attempt to find an exact answer using analytic calculus, which in this case is impossible. These candidates were apparently answering the question that they expected to be set rather than the one which had actually been set. In Mathematics, as in all other subjects, carefully reading and answering the question as set are necessary examination skills.

Question 2

This question was generally well done and, helped by the printed answer, many produced fully correct answers. The commonest error was to omit the negative sign when differentiating $\cos x + 1$. The order of the limits gave some difficulty. Instead of the correct $-\int_2^1 \mathrm{e}^u \, \mathrm{d}u$, an incorrect version $-\int_1^2 \mathrm{e}^u \, \mathrm{d}u$ was produced and the resulting expressions manipulated to the printed result and working like $-\left(\mathrm{e}^2 - \mathrm{e}^1\right) = -\mathrm{e}^2 + \mathrm{e}^1 = \mathrm{e}\left(\mathrm{e}-1\right)$ was not uncommon.

Some candidates got into serious difficulties when, through incorrect algebraic manipulation, they obtained $-\int \mathrm{e}^u \sin^2 x \, \mathrm{d}u$ instead of $-\int \mathrm{e}^u \, \mathrm{d}u$. This led to expressions such as $\int \mathrm{e}^u \left(u^2 - 2u\right) \mathrm{d}u$ and the efforts to integrate this, either by parts twice or a further substitution, often ran to several supplementary sheets. The time lost here inevitably led to difficulties in finishing the paper. Candidates need to have some idea of the amount of work and time appropriate to a 6 mark question and, if they find themselves exceeding this, realise that they have probably made a mistake and that they would be well advised to go on to another question.

Question 3

This question was also well answered and the general principles of implicit differentiation were well understood. By far the commonest source of error was in differentiating 2^x. 2^x, $2^x \ln x$ and $x2^{x-1}$ were all regularly seen. Those who knew how to differentiate 2^x nearly always completed the question correctly, although a few had difficulty in finding $\frac{\mathrm{d}}{\mathrm{d}x}\left(2xy\right)$ correctly.
A minority of candidates attempted the question by taking the logs of both sides of the printed equation or a rearrangement of the equation in the form $2^x = 2xy - y^2$. Correctly done, this leads to quite a neat solution, but, more frequently, errors, such as $\ln\left(2^x + y^2\right) = \ln 2^x + \ln y^2$, were seen.

It was noteworthy that a number of correct solutions were seen using partial differentiation, a topic which is not in the A level Mathematics or Further Mathematics specifications. These were, of course, awarded full marks.

Question 4

The majority of candidates knew how to tackle this question and solutions gaining all the method marks were common. However there were many errors of detail and only about 32% of the candidates gained full marks. In part (a), many candidates had difficult in differentiating $\sin^2 t$ and $2\tan t$. $2\tan t$ was more often differentiated correctly, possibly because the differential of $\tan t$ is given in the formula book, although $2\ln\sec t$ or $\ln\sec^2 t$ were often seen. Many could not differentiate $\sin^2 t$ correctly. $\cos^2 t$, $2\cos t$ and $2\sin t$ were all common. Nearly all candidates knew they had to divide $\frac{dy}{dt}$ by $\frac{dx}{dt}$, although there was some confusion in notation, with candidates mixing up their *x*s and *t*s. The majority knew how to approach part (b), finding the linear equation of the tangent to the curve at $\left(\frac{3}{4},\ 2\sqrt{3}\right)$, putting $y=0$ and solving for *x*. Some candidates used $y=0$ prematurely and found the tangent to the curve at $\left(\frac{3}{4}, 0\right)$ rather than at $\left(\frac{3}{4},\ 2\sqrt{3}\right)$.

Question 5

The first part of question 5 was generally well done. Those who had difficulty generally tried to solve sets of relatively complicated simultaneous equations or did long division obtaining an incorrect remainder. A few candidates found *B* and *C* correctly but either overlooked finding *A* or did not know how to find it. Part (b) proved very testing. Nearly all were able to make the connection between the parts but there were many errors in expanding both $(x-1)^{-1}$ and $(2+x)^{-1}$. Few were able to write $(x-1)^{-1}$ as $-(1-x)^{-1}$ and the resulting expansions were incorrect in the majority of cases, both $1+x-x^2$ and $1-x-x^2$ being common.

$(2+x)^{-1}$ was handled better but the constant $\frac{1}{2}$ in $\frac{1}{2}\left(1+\frac{x}{2}\right)^{-1}$ was frequently incorrect. Most recognised that they should collect together the terms of the two expansions but a few omitted their value of *A* when collecting the terms.

Question 6

Candidates tended either to get part (a) fully correct or make no progress at all. Of those who were successful, most replaced the $\cos^2\theta$ and $\sin^2\theta$ directly with the appropriate double angle formula. However many good answers were seen which worked successfully via $7\cos^2\theta - 3$ or $4 - 7\sin^2\theta$.

Part (b) proved demanding and there were candidates who did not understand the notation $\theta\mathrm{f}(\theta)$. Some just integrated $\mathrm{f}(\theta)$ and others thought that $\theta\mathrm{f}(\theta)$ meant that the argument 2θ in $\cos 2\theta$ should be replaced by θ and integrated $\frac{1}{2}\theta + \frac{7}{2}\theta\cos\theta$. A few candidates started by writing $\int \theta\mathrm{f}(\theta)\,\mathrm{d}\theta = \theta\int \mathrm{f}(\theta)\,\mathrm{d}\theta$, treating θ as a constant. Another error seen several times was $\int \theta\mathrm{f}(\theta)\,\mathrm{d}\theta = \int\left(\frac{1}{2}\theta + \frac{7}{2}\cos 2\theta^2\right)\mathrm{d}\theta$.

Many candidates correctly identified that integration by parts was necessary and most of these were able to demonstrate a complete method of solving the problem. However there were many errors of detail, the correct manipulation of the negative signs that occur in both integrating by parts and in integrating trigonometric functions proving particularly difficult. Only about 15% of candidates completed the question correctly.

Question 7

Part (a) was fully correct in the great majority of cases but the solutions were often unnecessarily long and nearly two pages of working were not unusual. The simplest method is to equate the **j** components. This gives one equation in λ, leading to $\lambda = 3$, which can be substituted into the equation of l_1 to give the coordinates of *C*. In practice, the majority of candidates found both λ and μ and many proved that the lines were coincident at *C*. However the question gave the information that the lines meet at *C* and candidates had not been asked to prove this. This appeared to be another case where candidates answered the question that they had expected to be set, rather than the one that actually had been.

The great majority of candidates demonstrated, in part (b), that they knew how to find the angle between two vectors using a scalar product. However the use of the position vectors of *A* and *B*, instead of vectors in the directions of the lines was common. Candidates could have used either the vectors $\begin{pmatrix}1\\2\\1\end{pmatrix}$ and $\begin{pmatrix}5\\0\\2\end{pmatrix}$, given in the question, or $\overrightarrow{AC}$ and $\overrightarrow{BC}$. The latter was much the commoner choice but many made errors in signs. Comparatively few chose to use the cosine rule. In part (c), many continued with the position vectors they had used incorrectly in part (b) and so found the area of the triangle *OAB* rather than triangle *ABC*. The easiest method of completing part (c) was usually to use the formula Area = $\frac{1}{2}ab\sin C$ and most chose this. Attempts to use Area = $\frac{1}{2}\text{base} \times \text{height}$ were usually fallacious and often assumed that the triangle was isosceles. A few complicated attempts were seen which used vectors to find the coordinates of the foot of a perpendicular from a vertex to the opposite side. In principle, this is possible but, in this case, the calculations proved too difficult to carry out correctly under examination conditions.

Question 8

Many found part (a) difficult and it was quite common to see candidates leave a blank space here and proceed to solve part (b), often correctly. A satisfactory proof requires summarising the information given in the question in an equation, such as $\frac{dV}{dt} = 0.48\pi - 0.6\pi h$, but many could not do this or began with the incorrect $\frac{dh}{dt} = 0.48\pi - 0.6\pi h$. Some also found difficulty in obtaining a correct expression for the volume of water in the tank and there was some confusion as to which was the variable in expressions for the volume. Sometimes expressions of the form $V = \pi r^2 h$ were differentiated with respect to *r*, which in this question is a constant. If they started appropriately, nearly all candidates could use the chain rule correctly to complete the proof.

Part (b) was often well done and many fully correct solutions were seen. As noted in the introduction above, some poor algebra was seen in rearranging the equation but, if that was done correctly, candidates were nearly always able to demonstrate a complete method of solution although, as expected, slips were made in the sign and the constants when integrating. Very few candidates completed the question using definite integration. Most used a constant of integration (arbitrary constant) and showed that they knew how to evaluate it and use it to complete the question.

Grade Boundary Statistics

The table below gives the lowest raw marks for the award of the stated uniform marks (UMS).

Module		Grade	A*	A	B	C	D	E
		Uniform marks	90	80	70	60	50	40
AS	6663 Core Mathematics C1			59	52	45	38	31
AS	6664 Core Mathematics C2			62	54	46	38	30
AS	6667 Further Pure Mathematics FP1			62	55	48	41	34
AS	6677 Mechanics M1			61	53	45	37	29
AS	6683 Statistics S1			55	48	41	35	29
AS	6689 Decision Maths D1			61	55	49	43	38
A2	6665 Core Mathematics C3		68	62	55	48	41	34
A2	6666 Core Mathematics C4		67	60	52	44	37	30
A2	6668 Further Pure Mathematics FP2		67	60	53	46	39	33
A2	6669 Further Pure Mathematics FP3		68	62	55	48	41	34
A2	6678 Mechanics M2		68	61	54	47	40	34
A2	6679 Mechanics M3		69	63	56	50	44	38
A2	6680 Mechanics M4		67	60	52	44	36	29
A2	6681 Mechanics M5		60	52	44	37	30	23
A2	6684 Statistics S2		68	62	54	46	38	31
A2	6691 Statistics S3		68	62	53	44	36	28
A2	6686 Statistics S4		68	62	54	46	38	30
A2	6690 Decision Maths D2		68	61	52	44	36	28

Grade A*

Grade A* is awarded at A level, but not AS to candidates cashing in from this Summer.

- For candidates cashing in for GCE Mathematics (9371), grade A* will be awarded to candidates who obtain an A grade overall (480 UMS or more) *and* 180 UMS or more on the total of their C3 (6665) and C4 (6666) units.
- For candidates cashing in for GCE Further Mathematics (9372), grade A* will be awarded to candidates who obtain an A grade overall (480 UMS or more) *and* 270 UMS or more on the total of their best three A2 units.
- For candidates cashing in for GCE Pure Mathematics (9373), grade A* will be awarded to candidates who obtain an A grade overall (480 UMS or more) *and* 270 UMS or more on the total of their A2 units.
- For candidates cashing in for GCE Further Mathematics (Additional) (9374), grade A* will be awarded to candidates who obtain an A grade overall (480 UMS or more) *and* 270 UMS or more on the total of their best three A2 units.

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