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Examiners' Report/ Principal Examiner Feedback

Summer 2010

GCE

Further Pure Mathematics FP2 (6668)

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Specification 6668

Introduction

It was clear that many candidates were well prepared for this examination and produced good, well presented work. Some, however, appeared to have not learnt some parts of the specification, particularly Taylor's theorem and transformations from the z-plane to the w-plane. Most candidates could remember their work from earlier units and apply it whenever necessary but others forgot essential information such as the double angle formulae. These could be quickly obtained from information in the formula book if required, so no candidate should be misquoting them.

Many candidates ran out of space before completing Q1 and/or Q4. Although it is tempting to use unwanted space elsewhere in the question booklet, this is a very risky tactic; candidates should always ask for extra sheets of paper. Some candidates wrote their extra work elsewhere in the booklet without making it clear where the end part of the question could be found and so risked having their work undermarked.

Report on individual questions

Question 1

This question was answered well by the vast majority of candidates. A small number of candidates started with $r=0$ rather than $r=1$ in part (b) and some failed to list required terms accurately or did not show sufficient terms to fully justify the cancellation. In part (c) a significant proportion of candidates attempted to evaluate f(1000)-f(100) rather than f(1000)-f(99) and many candidates lost the final mark because they did not give their answer to the required degree of accuracy. A very small number of candidates by-passed the general result that they had found in part (b) and evaluated $\frac{1}{3(100-1)}-\frac{1}{3(1000+2)}$.

Question 2

The majority of candidates either scored 2 or 5 marks for this question. Most candidates seemed to be familiar with the Taylor expansion but a large minority couldn't differentiate implicitly. Most of these did not have $\frac{\mathrm{d}x}{\mathrm{d}t}$ on the right hand side but a significant few obtained $-\frac{\mathrm{d}x}{\mathrm{d}t}+\sin x$ which led to the same series as the correct solution. The absence of chain rule cost several candidates 3 marks. The other common error was through a confusion of which symbols, x or t, to use. Many candidates seemed unfamiliar with this topic and appeared not to have covered it. Overall, this was a very simple question on Taylor Series and 5 relatively easy marks were lost.

Question 3

This question was either done well or badly with not a great deal between. In part (a) the more successful candidates seemed to be those who multiplied by $(x+3)^2$, formed a positive cubic and then sketched the graph to find those parts above the x-axis. Sketch graphs of $y = x + 4$ and $y = \frac{2}{x+3}$ were less common and often drawn without any further conclusions made by the candidate. It was disappointing to see many candidates multiply by $(x+3)$ without giving any consideration to the sign of $(x+3)$. Part (b) was not done well and it appeared that many candidates were unfamiliar or lacked understanding about the significance of the modulus signs. Few seemed able to write down the correct answer, often including another region along with $x > -2$. Those who drew a sketch of $y = x + 4$ and $y = \frac{2}{|x+3|}$ were usually able to arrive at the correct conclusion.

Question 4

In part (a) the modulus of z was found correctly by almost all candidates. It was disappointing to see so few candidates drawing a clear Argand diagram before even attempting to find the argument of z. The reliance on using arctan without the diagram usually led to an angle in the wrong quadrant. Hardly any candidates used degrees rather than radians. Most candidates could use de Moivre's theorem correctly in part (b) although some misread the question and tried to find the cube root rather than the cube. It was disappointing at this level to see candidates leaving the final answer in the $4096(\cos 2\pi + \mathrm{i}\sin 2\pi)$ form. There were some attempts at expanding $(x+\mathrm{i}y)^3$ which gained no marks because the question stipulated the use of de Moivre's theorem. There were some candidates who misread the question in part (c) and started from $w^4 = z^3$. Most candidates tried to find more than one root but it was again disappointing to see candidates believing that there was only one root to a fourth power equation. There were many completely correct solutions but legibility did make finding out what was going on difficult in some cases.

Question 5

The finding of the two values of θ in part (a) was usually correctly done but some candidates then wasted valuable time in taking their two θ values and working in a circle to find the *r* values - some of which were not equal to 2

In part (b) the vast majority of the candidates knew how to find the area enclosed between the two radius vectors and the curve simply as one integral. Others chose to split it into one area from 0 to $\frac{\pi}{2}$ minus the area from 0 to $\frac{\pi}{18}$ minus the area from $\frac{5\pi}{18}$ to $\frac{\pi}{2}$ - a long way round. Most of the candidates decided to use the integration method to find the area of the sector as well. Errors in integration were usually in the use of the double angle formula although most used it correctly. A minority of candidates forgot to square the function before integrating, but where this squaring had been done the subsequent integration of the trigonometric functions was well done. Where candidates fell down was in the careful application of the limits to their functions – writing things more neatly would have helped in a number of cases. Some forgot about the area of the sector of the circle completely. It was, however, pleasing to see many completely correct solutions.

Question 6

Candidates seemed to find this question difficult and many blank or minimal scoring attempts were seen. In part (a) most realised a line was required but some drew that line parallel to the real axis while others failed to identify their line in an appropriate manner. A significant minority thought the locus was a circle and others gave a diagram with both a line and a circle. This may have arisen due to adding the circle when attempting part (b) but it was not always clear which locus referred to which part of the question. Those who realised that for part (b) they needed the points of intersection of the line and the circle were able to write down the two complex numbers very quickly; others used really long calculations which did not always produce the correct answers.

Part (c) was the most challenging for many candidates. The substitution was not always made throughout the locus equation, resulting in a mixture of *w* and *z* which then led to a mixture of *x*, *y*, *u* and *v*. Some managed to get to $|30-6w|=|30|$ or 30 but then did not divide by 6. They often continued with the resulting large numbers and made mistakes in the algebra. A common mistake was to move from $|5-w|=5$ to $(5-u)^2+v^2=5$. Many circles were centred at the origin as $|30-6w|=|30| \Rightarrow |6w-30|=30 \Rightarrow |6w|=60$. Hence $|w|=10$ and the circle had cartesian equation $u^2+v^2=10^2$. Some candidates could arrive at a correct locus equation, sometimes even identifying the centre and radius of their ciircle, but could not (or forgot to) produce the corresponding cartesian equation.

Question 7

Most candidates produced a convincing argument for obtaining the given result in part (a). Those candidates who differentiated $y = z^2$ with respect to x produced the most elegant verification whilst there were a lot of candidates whose work was over long and their arguments disjointed. A small number of candidates were clearly working back from the printed answer as there was no evidence of any differentiation whatsoever in their working. In part (b), the vast majority of candidates realised that an integrating factor was required but many integrated $2\tan x$ or even $\tan x$ rather than the required $-2\tan x$. Those candidates who achieved the correct integrating factor were mostly accurate in their use of the double angle formula to integrate $\cos^2 x$ although a small number of candidates successfully used integration by parts.

Examiners were very surprised by a large number of responses to part (c). Many wrote down $y^{\frac{1}{2}} = \text{their } z$ and then stopped presumably unsure what to do next. Some candidates found the square root of their z rather than squaring it. Of those candidates who did realise that squaring was required, a large number squared individual terms rather than putting brackets round their answer to part (b) with a square symbol. Again, surprisingly, the mistakes made here were largely independent of the standard of their previous responses in the earlier parts of this question.

Question 8

This last question is usually tackled at the end with little time available and a certain amount of rush. Interestingly enough in this case many candidates attempted this question successfully and earned high marks. Most mistakes in part (a) resulted from inappropriate use of the product rule. Some candidates tried a complementary function at this point. Some even tried a particular integral of the form $y = \lambda x \sin x + \mu x \cos x$ and usually ignored the μ at the final stage. Most candidates however reached λ = 3/10. Candidates could score 3 marks easily in part (b) as all they had to do was add their complementary function (provided it was correct) to their particular integral. Some complications arose through candidates insisting on the use of $A\mathrm{e}^{5ix} + B\mathrm{e}^{-5ix}$ with or without the x. A few candidates tried to use $m^2 + 25m = 0$ as their auxiliary equation (and scored 0/3 for this part).

In part (c) candidates were again able to score good marks in spite of mistakes. Usually this took the form of incorrect use of the product rule. Use of $A\mathrm{e}^{5ix} + B\mathrm{e}^{-5ix}$ as the complementary function resulted in the use of simultaneous equations and further loss of marks when their solution was incorrect. Candidates with a graphical calculator were helped considerably in scoring the two marks available for part (b). Many otherwise very good solutions were spoiled by weak attempts here. There was a variety of diagrams, only a few of which even looked like a sine curve, let alone an increasing one. Polar coordinate type loops were not uncommon.

Grade Boundary Statistics

The table below give 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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