Examiners' Report/
Principal Examiner Feedback

Summer 2010

GCE

Further Pure Mathematics FP1 (6667)

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Introduction

The majority of candidates had been very well prepared for this paper and made a good attempt at most of the questions. Q1(a), Q3(a), Q5(a), Q7, Q8 and Q9 provided discrimination at the higher levels, as solutions to these questions required careful explanation to demonstrate understanding. The presentation of answers was usually good and most candidates understood that a proof requires each line of reasoning to be explained fully and clearly. However, there were a number of candidates who began 'show that' questions by stating the result they were trying to prove and then finished with one expression equalling an identical expression. This is not to be encouraged and candidates should be advised to start with one side and proceed to the other, or to take each side separately and make a clear conclusion that LHS=RHS.

Report on individual questions

Question 1

Most candidates found this question very accessible with many scoring 7 marks. In part (a) a minority of candidates failed to appreciate this was a "show that" question and omitted the key step of stating or using $i^2 = -1$. Other than this, numerical errors were very rare. Part (b) was very well done and the modulus was usually correctly given as 13. In part (c) most candidates appreciated that inverse tangent was needed, but many could not deal with the fact that the point was in the third quadrant. Wrong answers such as 1.97 and 1.18 were common. The need to identify the correct quadrant is essential for candidates hoping to continue to FP2 and FP3. In addition, a common error was to give the answer as -1.96, arising from rounding too early when finding –pi +1.18. In part (d) the argand diagram was usually correct, though there were some errors. Candidates should be advised not to extend their working to the very bottom of the page, past the scanned area. Many plots of –5-12i were beyond the scanned area.

Question 2

Generally this was a very accessible question where the vast majority of candidates gained full marks. They had a clear understanding of the process to find the inverse matrix and were able to apply it successfully in most cases. There were some arithmetical errors in finding the determinant and some candidates could not deal with the structure of the inverse matrix. A few did not substitute the given value for a. A much longer method involving simultaneous equations was much more prone to errors and fortunately not seen very often. In part (b) most understood the definition of a singular matrix and were able to solve their quadratic equation to give two accurate values for a. Some rejected the negative solution however, losing the last mark.

Question 3

Part (a) was straightforward and generally well done. Very few errors were made in the numerical evaluations (we do need to see these). There were, however, a minority of candidates who did not give the required conclusion, which ideally requires the sign change to be noted and a statement made of the interval for the root. In part (b) a few candidates attempted linear interpolation – maybe indicating a lack of practice with interval bisection. The numerical evaluations of f(1.45) and f(1.425), which are required, were well done by the majority of candidates. A noticeable number, however, did not produce a correctly stated conclusion – commonly no statement at all or just a single x value. Candidates should be made aware that, if the interval notation is used, the smaller number should be first – in this case [1.425, 1.45]. Part (c) was generally very well done with the vast majority knowing the Newton Raphson iteration. The most common error was not differentiating the constant (+2). A few had problems differentiating 1/x and a small number continued beyond one iteration.

Candidates should be encouraged to evaluate and write down intermediate values in their working, so that if a slip is made the examiner can see where. Failure to do so will have lost a mark here for some candidates.

Candidates should also be encouraged to check that their answers throughout a question are consistent.

Question 4

In part (a) long division and comparing coefficients were each used to good effect and errors were rare. Part (b) resulted in many good answers. Some however felt that 3, and even x + 3, was a root and others omitted the real root completely. Some confused roots with factors. It was disappointing at this level to see many candidates failing to solve a quadratic correctly. Candidates should be advised to quote the quadratic formula before using it to ensure that they earn the method mark. Completion of the square was often more successful in this question than use of the formula. In part (c) some included an x in their answer and others found a product instead of a sum. The vast majority earned this follow through mark however.

Question 5

In part (a) a variety of methods were used to verify that the given point was on the parabola, the most common being to substitute x or y into the equation. Many candidates instead found the value of 'a' and substituted into the parametric equations of the parabola, unfortunately losing this mark if insufficient explanation was given e.g. the general parametric equations were not quoted. Part (b) was very well answered by most candidates. Most found the coordinates of the relevant points and used the gradient formula correctly. A surprising number quoted or used the gradient as $\frac{x_2 - x_1}{y_2 - y_1}$. The main error was to use differentiation to find the gradient of the line, an error which was penalised heavily as it was a complete misinterpretation of the question.

Question 6

Part (a) was generally well done. Some however did have the columns of their matrix the wrong way round. Part (b) was similar to (a), but slightly less well done, with both sign and column errors. Candidates who have been taught to sketch a graph and transform a unit triangle/square performed well throughout this question.

There were a noticeable minority who appeared to have no idea about using matrices for transformations, which meant a loss of access to some fairly straightforward marks.
Many candidates multiplied their matrices in the wrong order for part (c). In this particular case it made no difference, and was not penalised, but it suggests that many candidates were not aware of the correct order.

The majority of candidates knew how to multiply matrices in part (d) and were able to achieve a correct answer. In part (e), most candidates were successful in obtaining the correct equations. Of those who didn't, the majority were able to follow through from their (c) and (d). As in many other questions, candidates should be encouraged to check that their final solutions are consistent with their matrices.

Question 7

Well explained logical explanations to both parts were rare and indicated a very good candidate. In part (a) those who began with the RHS and attempted to reach the LHS had most success. Elegant proofs were in the minority, with many candidates forced to start with the LHS and the RHS separately, and then attempting to meet in the middle. Those who adopt this approach should be aware of the need to reach a conclusion. Considering f(k+1) - 6f(k) was a productive starting point for some, yielding neat efficient proofs.

Part (b) was probably the toughest question on the paper. Far too many candidates ignored the "hence" and just considered f(k+1) – f(k) , because that is what they usually do . Of these, very few could deal convincingly with the 6^k term that resulted, and just as few returned to making f(k+1) the subject before drawing a conclusion. Of those taking the approach suggested in the question, relatively few could demonstrate convincingly that f(k+1) was divisible by 8. Many immediately reverted to the original definitions and went nowhere. One very good candidate proved that 4×2^k was divisible by 8 using induction, then used that result in the induction method to answer the question.

There was some, fortunately not too common, highly creative work with powers, but the major problems were the confused and muddled style of candidates' answers. It was rare to see A and B divisible by 8 => A+/-B divisible by 8. Also an accurate, concise, end statement making reference to the result being true for all positive integers (or equivalent) was extremely rare. Yet it was clear that teachers had tried hard to instil the essentials of the argument into their pupils, with many setting out "Basis, Assumption, Induction, Conclusion" or similar. Indeed 21% of the candidates achieved full marks on this question.

Question 8

Part (a) was extremely well done with very few errors. Several methods were used in (b) to find dy/dx, the most common being to differentiate c^2x^{-1}. Those who used implicit differentiation were also mostly successful as well as those who differentiated the parametric equations. Some simply quoted the derivative either in Cartesian or parametric form and these lost marks as the answer was given and this was a "show that" question. Most candidates however did show a clear, full solution to find the equation of the normal. There were some who failed to obtain a numerical value for the gradient so they ended up with a non-linear equation and this was penalised.

The algebra in part (c) was quite challenging for some but the standard of work was very pleasing. Most used simultaneous equations, one linear one the equation of the hyperbola. Usually candidates were able to eliminate one variable successfully to obtain a quadratic in one variable. They were then able to use a variety of methods to solve the quadratic. Many opted for the simple alternative of factorising, noticing that (x-3c) was a factor. Those who used the quadratic formula sometimes confused their powers of *c*. The method of completing the square to solve this quadratic usually led to errors. A small number of candidates used an alternative approach to (c). They began with $\frac{\frac{c}{t}-\frac{c}{3}}{ct-3c}=9$ and simplified the fraction to give a linear equation leading to a value for *t* and then to x and y. On the whole, candidates showed a good understanding of the concepts required to tackle this question and were able to apply their skills successfully.

Question 9

Showing the result in part (a) was fairly standard bookwork, and many answers were therefore surprisingly disappointing. The solution to a proof by induction question should be complete and precise. Often far too much was left to the examiner's imagination.

At the first sep when n=1, we expect to see both sides evaluated and shown to be equal, followed by a conclusion – usually "true for n=1". In this case there was often no reference to the LHS and there was a lack of conclusion.

"Assume true for n=k" is an essential step and should always be there in a proof by induction. This was often reduced to simply "n=k", which is not enough.

Adding the next term to check for n=k+1 was generally clear but a few added 1^2 or just (k+1) instead of $(k+1)^2$. There nearly always is a common factor at this stage, which makes the algebra fairly straightforward. Too many candidates expanded completely to find a cubic, which not all were able to factorise convincingly, many moving straight from a cubic to three linear factors in one step.

A candidate then needs to show clearly that they have the required result with (k+1) in place of n. A large number did not satisfactorily show this, just leaving the expression as 1/6 (k+1)(k+2)(2k+3) without any reference to substituting k+1.

A final conclusion is always required and should state that the result "by induction is true for all positive integers n". This conclusion was completely missing at times and incomplete on others.

In contrast part (b) was generally well done. A fairly common error at the beginning was to use 6 instead of sigma 6, causing an error of a factor of n. Very few candidates failed to expand (r+2)(r+3) correctly.

Many candidates made errors when taking n/6 or n/3 out as a factor – most commonly leaving an n in the last term. This lack of care did create problems in part (c).

In part (c) a majority of candidates were successful but quite a few problems were evident. Some candidates chose to ignore the word "hence" which condemned them straight away. Others only used the result from (b) for the sum from 1 to n, failing to see that they could also use it for the sum from 1 to 2n – thus creating a lot of extra work for themselves. The result for part (c) was given and a number of candidates missed out essential working on the way to this solution. Many candidates having obtained the wrong answer to (b) were convinced they had found the given solution. A small number having failed to get this answer correct went back and corrected their working in (b) – which is what we would hope to see. 30% of the candidates scored full marks on this question indicating the quality of the candidature on this paper.

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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