FSMQ

# Additional Mathematics

FSMQ **6993**

# Report on the Unit

# June 2010

**6993/R/10**

Oxford Cambridge and RSA Examinations

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## Foundations of Advanced Mathematics FSMQ (6989)

## REPORT ON THE UNIT

# Additional Mathematics – 6993

## General Comments

We can report yet another rise in the number of candidates this year, but it is distressing to note that there are still many candidates who are entered inappropriately. We have said before that this specification is intended as an enrichment specification for bright students. Typically, we would expect them to have gained, or be expected to gain, a good grade at Higher Tier of GCSE. Our impression was that this was not likely for many of the candidates. We feel that this examination is not a good experience for candidates who are only going to achieve 20% or so.

As in previous years, the rubric states that final answers should be given to three significant figures where appropriate. Where this was not done, a mark was deducted once in the paper.

There was evidence that some candidates did not finish the paper. We would like to stress that our feeling is not that the paper was too long, but that too much time was wasted taking a long way round a question or tackling it in the wrong way. This can take up a lot of time and in these cases it is not surprising that candidates did not finish.

Examples of where candidates applied long-winded methods were seen in the following questions.

**2** Candidates could not derive the binomial coefficients by calculation, finding it necessary to write out Pascal's Triangle for all 12 lines. Some candidates even attempted to multiply $(1 - x)$ by itself 12 times.

**3 (i)** Failure to use the remainder theorem, depending instead on long division.

**3 (ii)** Those who knew the remainder theorem attempted to factorise by trying "random" values of $x$, including such values as $x = 3$ which is not a factor of the constant term, $8$. Others, who had to engage in long division, often ignored all the work they had done in part (i) and started afresh.

**4 (ii)** It is arguable whether 1 – two terms is quicker than adding three terms, except that one of the terms in the subtraction had been found already in part (i). So the difference in the two methods is finding one term or three

**5 (i)** Most candidates ignored the help that the question gave in that one of the two roots of the quadratic were given. Most candidates solved the quadratic, often by the formula, to find $x = -1$.
In addition to testing for the nature of the turning point at $x = -1$, candidates did the same also for $x = 3$.

**5 (ii)** The question asked candidates to sketch the curve. Many candidates chose to plot the curve. This will, of course, earn the one mark available but the process of plotting the curve on graph paper will have taken them very much longer than drawing a simple sketch in the answer booklet.

**7 (i)** Candidates should have been aware that, for one mark, something very straightforward was being asked. Some covered a whole page with attempts to add the fractions.

**10** **(i)** It was surprising how many candidates substituted (0, 4) to obtain a correct value for $k$ and then went on to substitute also $(2, 0)$ and $(4, 0)$. Usually this led, incorrectly, to $k = 0$.

**10** **(ii)** Before substitution, some candidates multiplied out the three brackets. As with part (i) time was then wasted substituting the points on the $x$-axis which led to $0 = 0 \times c$ giving $c = 0$.

**11** **(i)** Using the cosine rule to find BF took longer than a second application of the sine rule.

**11** **(ii)** Candidates are faced with a right-angled triangle with one side and one angle. It was necessary therefore to use the tan ratio to find the height of the tower. Yet many used the sine rule again.

**Q11** **(iii)** To find the new angle of elevation in a right-angled triangle the tan ratio was once again required. Many found the third side by Pythagoras then used the sin or cosine ratios or even used the cosine rule. Some managed an even more time consuming method. Given the data of the triangle they found the area using $\text{Area } = \frac{1}{2}ab\text{Sin}C$ and then using $\text{Area} = \dfrac{100 \times \text{CF}}{2}$ to find CF. (Perhaps because their last trial run was using the 2009 paper?)

**12** **(iii)** The total area required candidates to find the area between the $x$-axis and the curve and then add to that the area of a triangle. Candidates did not see this “extra” bit as a triangle, however, and proceeded to integrate the equations of the lines, usually incorrectly.

It should be clear that candidates, who embark on alternative and much longer methods as described above will rapidly run out of time to finish the paper properly and additionally provide more opportunities to make errors.

## Comments on Individual Questions

### Section A

**1)** **(Inequality)**

Nearly always well done but with frequent errors in algebraic and numerical manipulation. It was disappointing at this level to see

$$5x > 7 \Rightarrow x > \frac{5}{7} \quad \text{or} \quad -5x < -7 \Rightarrow x < \frac{7}{5}.$$

$[x > 1.4]$

**2)** **(Binomial expansion)**

As outlined above, many candidates were unable to use the expansion in the form $(1-x)^{12} = 1 - \binom{12}{1}x + \binom{12}{2}x^2 - \binom{12}{3}x^3$ with an understanding of the numeric value of $\binom{12}{n}$. Many candidates who got the powers and coefficients correct did not take account of the signs.

$[1 - 12x + 66x^2 - 220x^3]$

**3)** **(Remainder Theorem)**
Most of the difficulties lay in the application of long-winded methods as described above. Some candidates failed to obtain full marks due to not answering the question, stopping with the factorised form of the function.
[(i) Remainder = 0, (ii) $x = -1, 2, 4$]

**4)** **(Binomial probability)**
Some candidates misread the question as throwing 6 dice rather than the stated 4. The requirement "at least" for some did not trigger the idea of taking the unwanted terms from 1.
[ (i) $\frac{625}{1296} = 0.4823$, (ii) $\frac{19}{144} = 0.1319$ ]

**5)** **(Turning points of a cubic)**
**(i)** A large number of candidates did not set their derived function to 0, although many of these did imply it by given the "solution" to be $x = -1, 3$. It was expected that candidates should determine the nature of the turning point by one of the three standard methods, but many missed it. Others did not find the y value corresponding to $x = -1$.
[$(-1, 12)$ is a maximum]

**(ii)** A sketch does not mean a plot on graph paper and only 1 mark was available.

**6)** **(Variable acceleration)**
It was pleasing to see so many candidates substitute the correct values for $u$ and $v$ and not be concerned about negative values. It was permissible to do the two parts the other way round as the time can be found without knowing the deceleration.
[ 2 m $s^{-2}$ , 42 secs]

**7)** **(Trigonometry)**
This question was poorly done, with few candidates making the connection between the question and the trigonometrical identity $\sin^2\theta + \cos^2\theta = 1$.

**(i)** The context confused even the better candidates, resulting in a lack of appreciation that the identity required the two fractions on the left to be added together.
Some of the good responses came from those who started with the identity and divided throughout by $\sin\theta \cos\theta$.

**(ii)** There was a general failure also here in not making the connection between the fractions and $\tan\theta$.

**(iii)** Errors here involved some very poor algebraic manipulation to get from what was given to a quadratic equation in $t$. Some candidates who got the whole question correct so far, then failed to find values for $\theta$, leaving the two values for $t$ found as their answer.
[15º, 75º.]

**8)** **(Variable acceleration)**
Most candidates understood that integration was required. Common errors were dividing throughout by 60, integrating the 60 outside the bracket as 60t and some even managed the integral of 60 to be $\frac{60^2}{2}$.
It was also distressing to see so many unrealistic answers. Spectacular answers included 120 m,
600 km and even in excess of 1 000 000 m.
[6250m]

**9) (Circle)**

(i) The most common error was to state the vector for half the diameter vector as the coordinates for the centre.

(ii) "Show that" was not properly understood by many. Writing $\sqrt{(8-1)^2+(2-3)^2}=5\sqrt{2}$ is insufficient work for full credit, as this could be simply writing down the answer.

(iii) The form of the circle required was often used well by many to find the correct equation. Others were less sure of the right way to proceed.

[(i) (8, 2), (iii) $x^2 + y^2 - 16x - 4y + 18 = 0$]

**10) (Modelling data with curves)**

In both parts (i) and (ii) most candidates were able to substitute the point (0, 4) into the given equation to find the constant, though it was disappointing to see many candidates making simple errors such as $4 = -16c \Rightarrow c = -4$.

The main problem was that, having found the value of $k$ and $c$ in each part, candidates then substituted also the other two points as well. Obtaining $0 = 0 \times k$ then caused confusion as most who did this then incorrectly deduced that $k = 0$, contradicting the earlier value found.

(iii) The idea of either function modelling the connection between the data was a concept that was not easy to grasp. Those that tried decided that the criterion for "better" had to be "simpler" and made a deduction accordingly. Not many involved the extra point that was given; those that did were able to deduce the correct answer. For full credit, however, a numerical demonstration was necessary.

[(i) $c = \frac{1}{2}$ (ii) $k = -\frac{1}{4}$, (iii) John's model as it fitted all the points.]

**Section B**

**11) (3D trigonometry)**

This question was a source of good marks even for the weaker candidates. However, many became confused by the fact that they could not easily visualise the situation in 3 dimensions. In such cases, drawing diagrams in the dimension required for that particular part is useful and not done enough by candidates.

(i) Many did not read the question fully and missed out the requirement to find BF.

(ii) The candidates who could visualise the fact that the tower was vertical when the rest of the diagram was horizontal did well. There were some, however, who engaged in very long-winded methods (see above).

(iii) A common error was to assume that C was at the midpoint of AB.

[(i) BF = 113.1 m, (ii) FT = 21.6 m, (iii) CF = 106.3 m, $\theta$ = 11.5°.]

**12) (Tangents, normals and areas)**

(i) Most candidates were aware of the tangent/normal rule, and most knew they had to differentiate.

(ii) Many students correctly tried to use simultaneous equations but often with the curve equation.

(iii) Attempts to work out the area were often very confused. The basic fact that the area of a triangle is $\frac{1}{2}\text{base} \times \text{height}$ even when the height is not a side of the triangle was forgotten by some. What resulted was often a plethora of irrelevant subtraction of integrals with resulting overlaps of area. Very few completed this part correctly.

[(i) $2x + 3y = 10$, (ii) (–4, 6), (iii) 21.25]

**13) (Problem solving using quadratic equations)**

This question was done very badly, which is surprising as many questions of a similar nature have been set in the past.

Many were unable to give valid expressions in part (i) and those who did rarely knew how to proceed in part (ii). Only part (iii) was tackled with any conviction but having obtained a solution to the quadratic equation, some failed to answer the question.

[(i) $\frac{72}{t}, \frac{72}{t+2}$ (iii) Ali takes 6 hours, Beth takes 8 hours.]

**14) (Linear programming)**

Most candidates scored at least 2 out of the first 3 marks in parts (i) and (ii), sometimes getting the first inequality sign the wrong way round.

(iii) The diagrams illustrating the constraints and feasible region were usually well done.

(iv) A large proportion of candidates failed to write down the objective function, though it was clear that they were able to determine the minimum cost. This was a problem for those who got the inequality sign in (i) the wrong way round as theoretically for their region the answer should have been 0. Few candidates seemed to be upset by this.

(v) This part also caused problems who obtained an incorrect feasible region as, once again, the answer should have been 0.

[$200x + 100y \geq 1500$, (ii) $y \geq x$, (iv) $C = 80x + 60y$, (5, 5), £700, (v) (7, 1) gives £620.]

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