FSMQ

Additional Mathematics

Free Standing Mathematics Qualification **6993**

OCR Report to Centres

June 2013

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This report on the examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the examination.

OCR will not enter into any discussion or correspondence in connection with this report.

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General Comments

It is worth noting, once again, that this specification is intended as an enrichment specification for able students. Typically, examiners would expect candidates to have gained, or be expected to gain, a good grade at Higher Tier of GCSE. Examiners feel that it is not a good experience for candidates who are only going to achieve 20% or so. Nearly 15% of all candidates failed to gain 20% marks.

Some candidates undertook rather more long-winded methods to obtain the answer required than was necessary. Additionally, there were two issues worthy of note:

1. The rubric states that 3 significant figures is the norm requirement. In more than one question, however, premature approximation resulted in inaccuracies further on in the question. Additionally, the use of the word "exact" in the question usually implies that calculators should not be used.

2. There are questions where the requirement is to "show that...". This is used where the answer required is to be used in a later part of the question and so, by giving the answer, it becomes possible for a candidate unable to do the first part to enter the question later on with a known starting point. However, this raises problems, particularly for the more able candidates. There is a common tendency for a candidate who cannot answer the question to make an incorrect attempt and then to write the answer given at the end. The more able candidate may struggle to understand exactly how much working is required given that the steps to the answer are obvious. It has to be clear to the examiner that the answer stated in the question has been achieved and where this does not happen, a penalty is applied.

Comments on Individual Questions

1 Gradients and perpendicular lines

Generally part (i) was well done and a proved to be a good starting question for most candidates. Some gave the answer incorrectly as 3. Some who rearranged the equation ignored the minus sign to get 1.5 and some retained the x to give $1.5x$. A few candidates attempted to use points on the line but, despite having two correct points, the outcome was rarely successful.

Part (ii) was also well done. Most candidates seemed aware of the relationship between the two gradients and successfully used their gradient in a correct form for a line.

2 Algebraic inequality

Many candidates scored fully by using the 'trial' method. Candidates working algebraically did not seem to like having to divide by 3 (possibly because it lead to a non-integer solution and the question asked for 'integer solutions') so many stopped at the $-8 < 3x < 11$ stage. For full marks, a set of integers was required and not simply an inequality.

3 Formation and solution of linear equation

As with question 2, many candidates undertook a "trial" method. Arriving at the correct age for Paul, however, did not fully answer the question as it required candidates to "form an equation in x". A few candidates, however, used their own letters for the variables which was accepted, but only rarely was a full solution seen as candidates then got confused, the letter x having been defined within the question to be something else.

It was a disappointment to see so few solutions written out in clear mathematical language. Even those candidates who wrote the correct equation [$4x + 5 = 3(x + 5)$] and then produced the correct answer rarely set out the working in a clear logical fashion. A number used the letter j for John's age initially, effectively producing two simultaneous equations which were solved correctly. This was of course acceptable, but rarely in these cases did examiners see the opening statement "let j be the age of John now" to match the statement in the question. Some found it difficult even to write the steps of the solution down in a logical sequence, sometime writing (often obliquely!) around the answer space making it hard to discern where the solution actually was.

4 Trigonometry

Most of the more able candidates understood that their calculator would not give an exact value for $\tan\theta$ and constructed an appropriate right-angled triangle, finding the third side exactly by Pythagoras. A significant majority found an acute angle from their calculator and then found $\tan\theta$.The string of decimal places written down might have given some clue that what they were writing was not exact. They might also have wondered how 3 marks were to be allocated to such a simple procedure! The idea that usually calculators will not give an exact value in these situations is not well understood.

5 Stationary points on a cubic curve

There was a good standard of differentiation seen, and most candidates knew that they must equate the derivative to zero and solve the resulting quadratic. There were few errors at this stage, but many candidates forgot to find the corresponding values of y having found correct x values for the stationary points. Of those candidates who did find the y values, a significant number found the value of y at x=1 to be 9.5 rather 6.5.

Not surprisingly those who gained full marks on part (i) did likewise on part (ii). A number who forgot to find the y values of stationary points nevertheless sketched a correct shape with correct stationary points. There were a variety of other shapes offered, indicating little knowledge of the essential features of cubic curves. Sketches were often of poor quality and did not portray single smooth curves.

6 Probability

Many candidates scored full marks on this question. Some candidates decided that 3 dice with 6 sides meant they were dealing with 6, or even 18, events and this was reflected in their calculations. The usual errors were evident, such as the failure to include a binomial coefficient in part (i), correct calculation of p(0) cubed but forgetting to subtract it from 1 in part (ii) and failure to distinguish between "at least one six" and "exactly one 6". A small minority attempted to solve the problem by adding the probabilities of 1, 2 and 3 sixes; few were successful.

7 Sine Rule

The Sine Rule was generally handled well and the correct answer obtained for Figure 7.1. Only a minority of candidates realised how to find the second angle, and several thought the two angles were the same having repeated the whole of the sine rule calculation. Some candidates tried using the cosine rule. This would, of course, produce a quadratic equation in the length of the base, giving two values and subsequently using either the sine or the cosine rules, the two angles. It was very rare to see any candidates find success with this method.

8 Area under curve

This was well done by many candidates, who realised what was required and set about the integration work confidently. A small number spoilt things for themselves by reversing the limits, while a few others went straight to 53% without finding the 3 or better s.f. answer and then drawing the correct conclusion. A small minority found 53% of 160 and compared the result with the result of their integration. It is worthy of note here of the problem alluded to above about a "show that..." question. A candidate who writes $\frac{256/3}{160} = 53\%$ has written something that is incorrect. It may be that the candidate has simply written down the answer without discovering that the answer, while not actually 0.53 is, as required, approximately 0.53. It is the responsibility of the candidate to demonstrate that he or she has arrived at the correct conclusion rather than write the given answer down. It is not unknown, of course, for candidates to write a great deal of incorrect work and still arrive at the given answer!

9 Completion of square

This question was perhaps the one that was answered the least well. Many candidates did not have the understanding of what they were being asked to complete it satisfactorily. In part (i) the most popular method was to expand the right hand side as a quadratic and compare coefficients. Only a small number were able to assert that by inspection the value of *a* was 4. The misunderstanding was perpetuated into part (ii) where a number tried to put the expression equal to zero and solve. More than 65% of candidates scored zero on this part. On the assumption that the quadratic expression could be made equal to zero meant that many candidates said that the maximum value could be infinity.

10 Trigonometry

Part (i) was answered well, though a number of candidates forgot to work out AB.

The easiest way to find the answer to part (ii) was to work on the right-angled triangle ACD. A significant number of candidates, however, worked on the scalene triangle ADB, thus making extra work for themselves. Additionally, some premature approximations meant that the final answer was a long way out from the correct answer.

11 Coordinate geometry of the circle

Part (a) was generally answered correctly by candidates who knew the form of the equation of a circle. A very common error was to write that the centre was at (2, 0). The radius was handled better.

Success in the rest of the question depended largely upon whether candidates could find the correct coordinates of A and B in (b)(i). This part was done well by many candidates. However, it was also common to see a significant number of candidates needlessly rearrange the equation of the circle before substituting $y = 2x + 6$. This, of course, gave candidates greater opportunity to introduce errors, normally in sign, which then deprived them of a number of marks.

Those who obtained a quadratic equation in 3 terms normally attempted to solve this sensibly.

A large number of weaker candidates attempt to solve these intersection problems without using algebra. Many were unsuccessful, even having obtained one or both points, because they failed to verify that the point(s) satisfied both equations.

Part (b) (ii) was dependent upon (b) (i) being correct so a significant number of candidates scored zero.

Part (b) (iii) was done quite well although, again, many candidates could not score full marks due to their points from (i) being wrong.

Part (c) was answered in two ways – using Pythagoras on the triangle involving the radius and half the length of AB or simply finding the distance between the centre and the midpoint of AB. For those with the correct coordinates for A and B this proved to be straightforward.

12 Variable acceleration

There are candidates who see this type of question and immediately think the constant acceleration formulae are needed. These are mechanically written down and applied to the problem without any real thought or understanding. It was pleasing to note, however, that the significant majority of candidates realised that this question was to do with variable acceleration and used calculus to work the question. Those attempting to use the constant acceleration formulae had the opportunity for a few marks but generally scored zero.

Part (a) was answered very well by the majority who knew they had to differentiate. Approximately equal numbers substituted $t = 4$ into their velocity function to get 0 and solving $v = 0$ to obtain $t = 4$. A minority chose to integrate and continued to do so in part (b) (i).

Part (b) (i), again, was almost trivial for those who knew what to do and a high number of candidates had scored 8 marks in just the first two parts of this question.

In part(b) (ii), it was most unusual not to see the correct answer. As this part was independent of the methods used in the first two parts and only involved substitution into the given formula, many candidates scored both marks.

The final part was the most testing (although still not difficult for many). A number of candidates merely plotted points and joined with line segments (giving rise to a polygon rather than a parabola for the velocity-time graph). There were many exotic graphs seen from candidates who had little idea of what to do in the entire question.

On the whole, this question was fairly straightforward for those appropriately entered and many candidates scored full marks.

13 Linear programming

The majority of candidates achieved the correct inequalities although there was some confusion with $y \le 2x$ with some writing $2y \le x$. This was frequently corrected when it came to the diagram. Some candidates neatly combined two of the inequalities as a single statement writing $x \le y \le 2x$ or the reverse. This topic seems to have been covered well by centres. Although this question was mostly done well, a significant number of candidates forgot the simpler inequalities $x < 20$ and/or $y < 30$, and so pursued different variations of inequalities involving x and y.

Part (ii) was confidently answered with most candidates picking up at least 3 marks. The majority of candidates correctly plotted their inequalities, although correct inequalities did not always lead to the correct line being plotted. Sometimes, those candidates who omitted $x < 20$ and/or $y < 30$ in part (i) did show these lines correctly on their diagram.

There was some confusion with the line connecting y and $2x$ with some candidates plotting $y = 0.5x$. The shading was usually correct although at times it was difficult to confirm the intentions of a candidate; it is satisfactory to "hatch" the wrong side of the line and is rather easier to see than the candidate who attempts to shade out the whole of one half of the grid.

The problem with part (iii) was a misunderstanding of the objective function. This was to do with the maximum number of students and so was the function $P = x + y$. The information regarding the uniform was an extra inequality. This often led to the incorrect answer being found. Candidates were able to state the objective function and plot the line but were often confused how to use it in order to find the maximum number of students. Most candidates knew to plot $40x + 50y \leq 2000$ and then plot this line with sufficient accuracy. The best answers confirmed that the value of 20 and 24 for x and y were optimal and in the acceptable region. The incorrect answer of (22, 22) often followed from correct lines and area, usually from trial and improvement, ignoring the correct area on their graph. Some candidates with flawed graphs (or no graph) reached the correct answer by realising they should take the maximum number of boys because 'they were cheaper'.

14 Algebra of a cubic curve

The best answers to this question showed a flair for both understanding the content and the most appropriate algebraic method. A minority of candidates ignored this question.

The majority of candidates correctly differentiated and substituted. This then usually led to a fully correct response. It was pleasing to see candidates give the equation of a line in a suitable format of 3 terms. Candidates tended to score full marks or no marks, sometimes failing to score anything because they failed to substitute $x = 1$ into their correctly differentiated function. Some weaker candidates knew to differentiate, but were unsure how to proceed (with some finding turning points). Stronger candidates understood the need to differentiate, and then found the equation of the normal in the correct manor, though many gave the equation of the tangent unnecessarily. Some did not have sufficient depth of knowledge to understand what the question in part (ii) was actually asking, and many candidates launched into solving cubics rather than the most likely route of equating the expressions for y for the curve and line.

In part (iii), a significant number of candidates substituted into the equation from part (ii) rather than demonstrating that the point fitted both the normal and the curve separately. This was particularly common for those candidates who had not found the correct normal in the first part. It was disappointing to see that most candidates only gave minimal evidence for their substitution into the correct curve and line, although were correct in the statements they made.

In part (iv), it was required to solve the cubic equation given in part (ii). These three values of x were the x coordinates of A, B and C in which two of the values were already known. It was therefore necessary only to find the third factor of the function. The best candidates used this fact and found no problem with the question. Unfortunately, the vast majority of candidates ignored the information that they already knew and started again to try to factorise the cubic, using the factor theorem or, using one of the pieces of information (only) embarking on long division. This process, as usual, caused algebraic problems and errors.

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