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Principal Examiner Feedback

June 2011

GCSE Mathematics (1380)

Higher Non-Calculator Paper (3H)

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June 2011
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1. PRINCIPAL EXAMINER'S REPORT – HIGHER PAPER 3

1.1. GENERAL COMMENTS

1.1.1. This exam paper was found to be a little more demanding than some that have been taken in previous sessions however there were some very good responses to the more demanding questions near the end of the paper.

1.1.2. It was disappointing to see poor responses to questions where a description of a process was asked for or for where a reason for an answer was required. This was particularly the case in question 17, the geometric proof question. It was very rare to see a well laid out systematic approach to this question.

1.1.3. Generally speaking the standard of straightforward algebraic knowledge was good however once the question moved into the application of these techniques the quality of work seen deteriorated. The quality of the algebraic manipulation was very poor with many candidates making elementary errors in their attempts to simplify expressions.

1.1.4. Q1 – Q9, Q12, and Q20 were tackled with the most success.

1.1.5. Q10, Q11, Q13 – Q19, Q21(b) and Q23 – Q27 were less successfully completed.

1.2. REPORT ON INDIVIDUAL QUESTIONS

1.2.1. Question 1

This question was very well understood and very well answered with 83% of candidates gaining all three marks for correctly calculating the amount of every ingredient. 13% of candidates obtained two marks for obtaining the correct value for at least one amount correctly. Candidates found that calculating the weight of the sugar was more difficult than the other quantities. One mark was awarded for candidates that attempted to find the amount for 1 flapjack or for attempting to use the ratio 2 : 3 and 1% of candidates were able to show this. Only 3% of candidates did not gain any marks.

1.2.2. Question 2

Though this is a well understood topic a surprising number of candidates (15%) did not manage to link the number of pages to the time taken to read them with a simple description. The mark for part (a) could have been achieved by writing positive correlation or for saying the more pages the longer the time. Many candidates just stated 'positive' or positive relationship or tried to explain the number of pages she read in an hour and these scored no marks. Several also mentioned direct proportion which gained no marks by itself but was not penalised if it appeared in conjunction with a correct response.

Part (b) was very well answered with 94% of candidates gaining both marks. A further 1.5% gained one mark for drawing a viable line of best fit if their estimate fell outside the range 6.5 to 8.5 inclusive.

1.2.3. Question 3

Part (i) was well answered with 93% of candidates gaining the mark.

Part (ii) however was very poorly answered with only 39% writing corresponding angle (F angles were accepted). It was surprising how many candidates thought the angles were alternate or said they were in a straight line. Many students wrote that the answer was due to 'parallel lines' or 'parallel angles' and therefore gained no marks.

1.2.4. Question 4

This question was well understood with 40% of candidates gaining all three marks for correctly estimating the calculation. A further 24% gained two marks for correctly estimating the numbers and carrying out a calculation with two of them and one mark was awarded to the 23% of candidates who were able to round two of the numbers to one significant figure. Rounding 0.46 to 1sf caused problems as did dividing by 0.5 which was frequently calculated as division by 2. Some candidates did not understand estimate and tried to work out the solution using long multiplication and division and therefore scored no marks.

1.2.5. Question 5

Substituting negative values into a quadratic was correctly answered by only 25% of candidates as many gave a negative answer, thinking that -2^2 was -4 and some multiplied before squaring whilst the reverse process was even less successful with only 17% gaining the marks.

Part (b) was much more successful with 78% of candidates gaining both marks and only 8% gaining no marks. One mark was awarded to the many who only failed to find the square root at the end or who thought $\sqrt{9}$ was 4.5

1.2.6. Question 6

55% of candidates remembered that the total of the exterior angles of a polygon is 360º and were able to divide this by 30º correctly and were awarded two marks. However many candidates were unable to carry out the division correctly and 3% of them scored one mark. It was disappointing to that 42% scored no marks at all. A significant number found 180/30 giving their answer as 6. Many thought that the exterior angles added to 180 rather than 360 and some tried to use the sum of interior angles, setting up a correct equation but generally being unable to solve it. Others listed the sums of interior angles, dividing by the number of sides, until they obtained 150.

1.2.7. Question 7

This reflection was poorly answered with many candidates reflecting the shape in the x or y axis or other vertical or horizontal lines. Only 40% of candidates were able to reflect the shape in the correct line, $x = -1$, but 37% of candidates were awarded a mark for a reflection in a line of the form $y = m$ or $x = n$ ($n \neq -1$) those who were successful were frequently seen to have drawn the line $x = -1$ on the grid.

Part (b) again was not very well answered with many candidates unable to describe the correct translation as a vector or even as a description in words. Very often the word translation was omitted and some gave a combination of transformations when a single transformation was asked for. Many candidates who attempted the vector notation often omitted the word "translation" but used instead, transferred, transformed or moved, none of which were acceptable. Vectors were often given as the reverse of the correct one. A significant number of candidates tried to describe the transformation of Q onto P rather than P onto Q. Only 16% of candidates scored both marks whilst 36% gained one mark.

1.2.8. Question 8

Though candidates understood what they had to do in this question that is a regular visitor to these papers it was not very well answered with only 38% of candidates gaining all three marks. Frequently the time scale was omitted and the response boxes often overlapped. More able candidates used inequalities, because the data was continuous, not appreciating that this was not a suitable representation for a questionnaire.

In part (b) the biased nature of the sample was frequently ignored by candidates in favour of responses such as swimming was a leisure activity, not a form of exercise or people might only be there for fun or the questionnaire might get wet! Another common failing was to write a criticism of their own question from part (a).

1.2.9. Question 9

This question was very well understood with 68% of candidates gaining the mark for the first two terms in the sequence. In part (b) 54% of candidates were then able to gain both marks for giving the nth term of the sequence but a large number, 32%, gained no marks usually for writing $n + 4$. Candidates who wrote $4n + a$ ($a \neq -3$) obtained 1 mark. It was noticeable that those students who found the "zero th term often then wrote their answer as $3n - 4$ rather than $4n - 3$.

1.2.10. Question 10

This multi-step question did make many of the candidates think about putting a successful strategy in place for solving a problem. 27% of candidates scored no marks,11% of candidates scored either one mark, or two marks, 12%, usually for calculating part of or all of the area of the cross section correctly. Three marks were obtained by 29% usually for including a calculation to show that they were multiplying their area by 8 g/cm³. The 8% of candidates that gained four marks were those that managed to change the 2 metres for the length of the prism into centimetres and multiply it by their cross sectional area. The fifth mark was awarded to 13% of candidates that obtained the correct answer accompanied by the appropriate unit. The most common errors were failing to convert the units and dividing by 8 instead of multiplying to find the mass. Many errors were also made in working out the area of the L shape with perimeter being the most common.

1.2.11. Question 11

This ratio question was answered correctly by 41% of candidates. 19% of candidates gained one mark for writing any three values in the ratio 1 : 3 : 6 thus showing that they had an understanding of the problem. Some candidates, 3%, scored two marks for showing that they were going to divide £54 by (1 + 3 + 6) and then multiply by 6 whilst others used a decomposition method to show £50 as £5 : £15 : £ 30 followed by £4 as 40p : £1.20 : £2.40

Frequent incorrect methods were the use of 1 : 2 : 3 to give 9,18,27. Surprisingly several candidates found all 3 correct amounts and then selected the wrong value, thus losing a mark. Many candidates used a trial and improvement method to solve the question but the extra £4 proved difficult to share correctly. Other ratios seen were 1 : 2 : 3 and 1 : 3 : 5. Some merely divided 54 by 3 and based their incorrect solutions around £18 and so missed the point of the question.

1.2.12. Question 12

This question on indices was very well understood with 95% gaining the mark in (a)(i) and 90% gaining the mark in (a)(ii).

Part (b) was not so well understood with only 19% gaining both marks. Partial credit, one mark was given for correctly dealing with one aspect of the cancelling and this mark was awarded to 58% of candidates. Only 23% of candidates scored no marks. Most candidates managed to cancel the *y*'s or get the 4 correct. Very few managed a fully correct answer, as they often didn't know how to deal with the *x*'s and the most common incorrect answer seen was $4x$. A few proceeded correctly to $\frac{12}{3x}$ but went no further. Some candidates who obtained $4x^{-1}$ went on to further refine their answer incorrectly to $\frac{1}{4x}$.

1.2.13. Question 13

The frequency polygon question was correctly answered by 39% of candidates. One mark was awarded to the 23% of candidates who plotted correctly consistently at the ends of the class intervals or who made one plotting error or who joined the last point back to the first point to make a polygon! Surprisingly on a higher tier paper 38% of candidates scored no marks usually because they were unable to handle the scale correctly on the frequency axis.

1.2.14. Question 14

This question was very poorly answered with only 10% of candidates gaining full marks for an accurate 30º construction. Many candidates used a protractor to draw the angle then attempted with spurious arcs to pretend they had constructed the 30º angle. The most successful attempts drew a 60º angle either using an equilateral triangle or using the standard construction and gained one mark (7% of candidates) whilst a further 0.3% of candidates then bisected their angle to gain the second mark. Significant numbers of candidates knew how to bisect an angle but had not managed to successfully construct the 60 angle first. 83% of candidates scored no marks at all.

1.2.15. Question 15

This question was not done well. In part (a), few candidates could both measure the distance between Church and Castle accurately and use the scale of the map to find the real distance. A very common incorrect answer was 82 000. The conversion between metric units continues to be a problem for many candidates. The statement of a correct conversion factor, such as 1m = 100cm, was comparatively rare, as was a correct answer in the required range. It was not uncommon to see the incorrect calculation $8.2 \times 10000 = 802000$.

In part (b), only the best candidates were able to find the bearing of the castle from the church. Common incorrect answers here were 50, 310 and 230, showing, perhaps, the full range of misconceptions surrounding this topic.

This question tested various algebraic techniques:-

(a) Expanding a single bracket, with a success rate of 84% for 2 marks and 9% for 1 mark; a common error was to write $x^2 + 2$
(b) Expanding two linear brackets, with a success rate of 55% for 2 marks and 23% for 1 mark; Most candidates were able to find 4 terms but some made errors with signs. Students should be encouraged to write out the complete expansion before simplifying.
(c) Factorising an algebraic expression of the form $ax^2 + bx$, with a success rate of 52% for 2 marks and 16% for 1 mark. Many candidates only partially factorised the expression thus losing a mark
(d) Factorising the difference of two squares with a success rate of 37% for 1 mark. Candidates either knew the factors of the difference of two squares or had completely incorrect answers; several thought that there were no factors at all.

1.2.16. Question 16

This question on fractions was a tale of two parts. Part (a) was slightly less successful than part (b) with 41% gaining 3 marks for the correct answer in its lowest terms and two marks for the correct answer without cancelling whilst 3% of candidates gained one mark for remembering to invert the second fraction. Some unsuccessful candidates remembered that something needed to be turned upside down but inverted the wrong fraction or both fractions. Another non-productive start point seen regularly was making the denominators the same. It was disappointing that 49% of candidates scored no marks.

In part (b) the success rate was a little higher with only 52% of candidates gaining full marks. 9% of candidates obtained one mark for writing one of the fractions with the correct denominator and a further 9% gained a second mark for writing both fractions correctly with a common denominator. It was common to see 15 in the denominator but uncommon to see a correct method for the numerators. Converting mixed numbers to improper fractions on its own was not rewarded, though those who did so were more likely to get the answer correct. Those awarded 2 marks failed to make the subtraction correctly with $-\frac{1}{15}$ as a typical wrong answer. Here 31% of candidates scored no marks.

1.2.17. Question 17

This question was very poorly answered with only 1% of candidates able to put together a coherent proof and so gain 3 marks. One mark was obtained by 29% of candidates either for writing and proving which angles were 90º in the two triangles or for recognising which of the angles corresponded with each other in the two triangles. For a partial proof 0.3% of candidates gained two marks. Candidates seemed to fail to understand what they needed to do for this question with the majority only managing to recognise that APC = BPC = 90. Many just showed the 90 degree symbol in the diagram and thus gained no marks. Very few seemed to have some familiarity with a formal proof in geometry, many produced diagrams with lots of arrows. Others blithely asserted that CP bisected angle ACB and 45 degree angles appeared all over the place.

Many tried to use the proofs for congruency. It was noticeable that some candidates did not know how to write an angle, making this an even more difficult question to gain marks in. Many missed out even on the first mark by not correctly identifying angles with three letters or using vague descriptions or using pictures. Some compared the wrong triangles by using triangle ABC. 70% of candidates scored no marks at all.

1.2.18. Question 18

This question was well understood with 70% gaining the mark for selecting the correct modal class and 80% gaining the mark for completing the cumulative frequency table correctly.

In part (c) the cumulative frequency curve was drawn correctly by 60% of candidates whilst a further 21% gaining one mark for an incorrect plot or for plotting the curve at the wrong point of the class interval or plotted the points but failed to join them up.

In part (d) 18% of candidates gained the mark for finding an estimate for the median from their cumulative frequency graph. This was too often done by eye rather than reading from the graph. Those who did use the graph often misread the horizontal scale and gave 106 as their answer.

1.2.19. Question 19

In this standard solution of a pair of simultaneous equations the correct solutions were found by 27% of candidates. 7% of candidates gained the mark for a complete method to eliminate one of the variables or for rearranging and substituting to eliminate one of the variables. Candidates were very successful at multiplying to find equivalent equations, however, many candidates could not subtract negatives which made the question more difficult and which made subsequent substitution a challenge that they usually failed to succeed at. Those who managed this step were able to substitute the value found into one of the equations but many struggled with simplifying $\frac{49}{14}$. Candidates seemed to have difficulty in handling negative numbers. The candidates that then substituted correctly and found the solutions will have gained two marks. It was disappointing to see that only 11% of candidates managed to do this on a higher tier paper.

1.2.20. Question 20

In this question it was expected that candidates would compare a specific point such as median, highest or lowest mark or upper or lower quartile for one mark and then a measure of spread for the other mark by comparing the range or interquartile range. It is expected that the correct technical language is used in such questions and words such as average and wider spread are deemed to be too inaccurate. 25% of candidates gained both marks and 43% gained one mark. Comparative language needs to be used eg boys maximum score was *higher*; just listing values read from the diagrams was insufficient as were general statements about consistency or distribution.

1.2.21. Question 21

In this question on straight line graphs 13% of candidates were able to find the gradient of the straight line with 16% of candidates gaining a mark for an appropriate method.

Finding the equation of the straight line parallel to the given line was less well answered with only 10% of candidates writing the correct equation and another 15% gaining one mark for using their gradient from part (a) or for establishing the correct intercept of 5 on the y axis.

1.2.22. Question 22

In part (a) of this question on irrational numbers and fractional indices 12% of candidates were able to gain one mark for establishing a correct root or power or reciprocal and a further 16% gained both marks for the correct answer. A common error was to interpret $\sqrt[3]{27}$ as $27 \div 3$. This would often be followed either by squaring or multiplying by -2.

In part (b) most candidates realised they had to rationalise the denominator of the fraction or equated the given fraction to $a + b\sqrt{2}$ and multiplied this by $\sqrt{2}$ and 14% gained one mark for doing this. Full marks were only gained by 3% of candidates. The absence of the use of brackets when multiplying by $\sqrt{2}$ led to errors in subsequent work and there was the usual inappropriate 'cancelling' in many scripts.

1.2.23. Question 23

This question on changing the subject of the formula was poorly answered with only 7% of candidates gaining all four marks. Three marks were obtained by the 0.6% of candidates that factorised k outside a bracket leaving $t - 1$ or $1 - t$ inside the bracket with 3% of candidates gaining two marks for taking the terms in k to one side of the equation and one mark was obtained by the 21% of candidates who were able to multiply both sides of the equation by $t - 2$.

Many knew the first stage was to multiply by $(k - 2)$ but failed to multiply out the brackets correctly. Few could collect the k terms on one side and the final problem was the inability to factorise. A few candidates thought that the solution was to simply interchange t for k. Multiple attempts were frequently seen often leading to no marks being awarded as there was a choice of methods and candidates did not tell the examiner which attempt they wanted considered.

1.2.24. Question 24

Histograms are a regular visitor on these papers but only 32% of candidates could work out the frequencies in part (i) and 46% in part (ii) from the graph to write in the table.

In part (b) 31% of candidates were able to draw two bars correctly and 37% gained one mark for drawing one bar correctly.

1.2.25. Question 25

This question about the surface area of a cone and a hemisphere was not very well understood by candidates. Many candidates did not realise that the areas of the bases could be ignored as they were equal, some equated them and cancelled them out, which was fine and some only included the circle on one of the shapes which was a mistake. 14% of candidates were able to equate the areas correctly in terms of the radius *r* and were awarded one mark as were those candidates who found an expression for one area in terms of *x*. Two marks were awarded for a correct equation connecting the areas in terms of *x* and 6% gained these two marks. If candidates were able to find an expression to connect the slant height of the cone, the vertical height of the cone and *x* using Pythagoras' theorem then three marks were gained. 2% of candidates gained these three marks. Fully correct solutions were only obtained by 1% of candidates.

Some candidates were not aware that the formula for the surface area of a sphere and cone were given at the beginning of the exam paper whilst which highlights the need to be familiar with the formula sheet. Others incorrectly used the formulae for volumes. Although some did write down correct formulae, they did not realize r should be replaced by *x*. Many candidates did manage to equate surface areas (not always correctly) but few realised they needed to use Pythagoras and of those not many were able to manipulate the expression to a final simplified answer. Several confused their *l* and *h* and wrote that the curved surface area of a cone was π*xh* and going on to show that $h = 2x$.

1.2.26. Question 26

Candidates, even on the higher tier, often struggle with vector algebra and this was certainly true in this question. Part (a) was fairly straightforward and 42% of candidates gained the mark. In part (b) only 4% of candidates obtained the full 3 marks for showing the two vectors were parallel though 5% gained 1 mark for writing a correct expression for *OP* and a further 2% gained the mark for simplifying the expression correctly. The majority of candidates failed to deal with the ratio correctly, assuming that *OP* was $2a + \frac{2}{3}(3b - 2a)$.

Of those who did obtain OP = 6/5 (a + b) many did not then go on to say that they were parallel. There were many blank spaces. The few who chose the $3b + \overrightarrow{DA}$ route seldom remembered to reverse the direction of $\overrightarrow{AB}$.

1.2.27. Question 27

Only 6% of candidates were able to find the correct solution to this fractional equation but 18% of candidates either wrote the correct common denominator or multiplied one term by 2 or $(x + 1)$ or $2(x + 1)$ and then a further 3% gained two marks for attempting to multiply all the terms by $2(x + 1)$ most usually failed to obtain this mark because they had forgotten to multiply the right-hand side of the equation by 2(x+1). Once again the absence of brackets led to errors.

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Order Code UG028362 June 2011

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