Examiners' Report/
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Introduction

This paper proved to be accessible to many of the candidates and there was little evidence of them being short of time. The paper afforded a typical E grade candidate enough opportunity to gain marks across the majority of questions. There was however, in the later questions more discriminating material for the grade A, B and C candidates. Question 5 proved challenging to nearly all candidates with only 2.8% of the candidature able to gain full marks.

In Question 2(a), it was clear to examiners that some candidates were not aware of the special form of the binomial expansion of $(a+b)^n$, for integer n. Those candidates wrote $(3+bx)^5$ in the form $k\left(1+\frac{bx}{3}\right)^5$, and applied the binomial expansion for $(1+x)^n$ were usually less successful in gaining all 4 marks. Candidates are advised to show sufficient working in order to make their methods clear to the examiner.

In summary, questions 1, 3, 5(a), 6(a), 6(b), 6(c), 8(b), 9(a) and the first three marks in 9(b) were a good source of marks for the average candidate, mainly testing standard ideas and techniques; and questions 2, 4, 5(b), 7, 8 and 9 were discriminating questions at the higher grades. In question 8(b), a number of stronger candidates stopped after finding $x = 3$. The majority of them did not realise (or forgot) that the question required them to find the minimum value of L, but a minority of them, however, did in fact believe that 3 was the minimum value of L.

Report on individual questions

Question 1

Most candidates attempted this question and many achieved full marks. In part (a), a significant number used long division in order to find the remainder, many successfully but others making sign errors. Those that used the remainder theorem and found $f(1)$ almost always gained full marks.

In part (b), a significant number of candidates gained only one mark as they were able to show that $f(-1) = 0$ successfully but then did not make any comment to the effect that $(x+1)$ was then a factor. Others clearly did not know what was meant by the factor theorem and used long division for which they did not gain any marks.

Part (c) was completed successfully by many candidates. The majority found the quadratic factor by long division rather than inspection of coefficients. Some of those candidates who used a method of long division on occasion arrived at the incorrect quadratic factor because of sign errors. Nearly all candidates who arrived at the correct quadratic factor were then able to factorise it correctly. A number of candidates did not obtain the final mark as they did not write all 3 factors together on one line at the end of their solution.

Question 2

The most successful strategy seen in part (a) was for candidates to use the formula for $(a+b)^n$ to expand $(3+bx)^5$ to give $(3)^5 + {}^5C_1(3)^4(bx) + {}^5C_2(3)^3(bx)^2 + \ldots$. A few candidates used Pascal's triangle to correctly derive their binomial coefficients, whilst a few other candidates used $n = 3$ in their binomial expansion resulting in incorrect binomial coefficients. A significant number of candidates made a bracketing error to give $270bx^2$ as their term in x^2. Some candidates did not consider powers of 3 in and wrote $1 + 5bx + 10b^2x^2 + \ldots$, whilst a few other candidates did not include any x's in their binomial expansion.

A minority of candidates wrote $(3+bx)^5$ in the form $k\left(1+\frac{bx}{3}\right)^5$, and proceeded to apply the $(1+x)^n$ form of the binomial expansion. Those candidates who used $k = 3^5$, usually went on to gain full marks. A significant number of candidates either used $k = 1$ or $k = 3$ to achieve incorrect answers of either $1 + \frac{5b}{3}x + \frac{10}{9}b^2x^2 + \ldots$ or $3 + 5bx + \frac{10}{3}b^2x^2 + \ldots$ respectively and gained only 1 mark for this part.

Part (b) was also fairly well attempted when compared with previous years but there were still a significant number of candidates who did not understand that the coefficient does not include the x or x^2 part of a term. These candidates were usually unable to form an equation in b alone. A common error was for candidates to form an equation in b by multiplying the coefficient of x^2 by 2 instead of the coefficient of x. A few candidates formed an equation in b using the first and the second terms rather than the second and third terms.

A handful of candidates ignored their binomial expansion and gave the answer 2, using their flawed logic of "twice 2" being equal to "2 squared". Other less common errors included either giving an answer of $b = \frac{1}{3}$ following on from $810 = 270b$ or $b = 1.5$ following on from not multiplying either coefficient by 2.

Question 3

In part (a), the majority of candidates were able to use logs to correctly obtain 1.43, although some failed to round their answer to 3 significant figures as required by the question. It was common to see either method of $x = \dfrac{\log 10}{\log 5}$ or $x = \log_5 10$. A few weaker candidates were able to achieve the correct answer by a method of trial and improvement.

About 60% of the candidates were able to answer part (b) correctly, with a small number offering no solution to this part. Although most candidates appreciated the need to remove logs, a number were unable deal with the -1, often rewriting $\log_3(x-2) = -1$ as $\log_3(x-2) = -\log_3(3)$ or $\log_3(x-2) = \log_3(-3)$ and then cancelling the logs from each side to get $x - 2 = -3$.

Another far too common response, showing a clear lack of understanding of the laws of logarithms, was to replace $\log_3(x-2)$ with $\log_3 x - \log_3 2$ and then $\log_3\left(\dfrac{x}{2}\right)$ or even $\dfrac{\log_3 x}{\log_3 2}$. Those candidates who correctly removed the logarithm by writing $x - 2 = 3^{-1}$, usually achieved the correct answer.

Question 4

Most candidates attempted this question with varying degrees of success. Those candidates who completed the square correctly tended to gain full marks in parts (a) and (b). Some candidates who arrived at the correct equation for the circle then gave the coordinates of the centre with the signs the wrong way round i.e. $(2,-1)$.

Some candidates realised that they needed to have $(x+2)^2$ and $(y-1)^2$ but failed to subtract a constant term when completing the square. These candidates usually gave $\sqrt{11}$ as the radius. Others added the constants when completing the square and obtained $r=\sqrt{6}$, or did not square the constants and obtained either $r=\sqrt{14}$ or $r=\sqrt{8}$. Some candidates incorrectly squared the 1 from the y bracket to give $1^2=2$.

Some candidates failed to complete the square correctly and factorised x and y to get $x(x+4)+y(y-2)=11$ leading to answers of $(-4, 2)$ for centre and $\sqrt{11}$ for radius. A small minority of candidates who compared $x^2+y^2+4x-2y-11=0$ with $x^2+y^2+2gx+2fy+c=0$ were usually successful in answering parts (a) and (b).

In some instances, part (c) was completed more successfully than parts (a) and (b). A notable number of candidates achieved full marks in (c) by using the equation given on the question paper having gained no marks in parts (a) and (b). Many candidates understood that intersections with the y-axis can be found by substituting $x=0$, although a significant minority substituted $y=0$ into their circle equation. When substituting $x=0$ it was preferable for candidates to use the original form of the equation - thus avoiding any errors they had introduced in manipulation for parts (a) and (b). Those that used the squared form of the equation of the circle on occasion substituted $(x+2)^2$ as 0 rather than just x. Many candidates solved the resulting equation either by use of the formula or by completing the square, although a number of those who completed the square omitted one of the two exact solutions. A minority of candidates did not give their answer in a simplified surd form.

A very small minority of candidates attempted part (c) by drawing a diagram showing the circle in relation to the axes, followed by a solution involving Pythagoras.

Question 5

Part (a) was well answered with the vast majority of candidates using the correct sector formula $\frac{1}{2}r^2\theta$ or perhaps finding a fraction of πr^2. Occasionally an incorrect formula was quoted. Often the exact answer 6π was given, but otherwise rounding errors were rare. Only a few candidates attempted to convert θ to degrees.

Surprisingly, for a question which only required knowledge of GCSE work, part (b) proved to be the worst answered question on the paper. Although a good number of candidates realised the question was a combination of circle properties with trigonometry, only a small number of these were able to proceed successfully by writing down a correct equation for a right-angled triangle. It is disappointing at this level to see a number of candidates who used the sine rule, and even the cosine rule, when dealing with right-angled triangles. There were however, neat, succinct solutions from some good candidates, and a few correct solutions using more complicated strategies. There were occasional correct solutions using the ratios of the edges of a 30°, 60°, 90° triangle but many complicated, incorrect methods were often seen. While many candidates left this part blank, some resorted to guessing the value of *r*. A number of candidates correctly guessed that *r* was 2 and other common wrong guesses were 1.5 and 3. There were many wrong answers for *r*, some of which gave the area of the circle greater than the sector area found in part (a); a problem when it came to answering part (c).

After failing to answer part (b), many candidates ignored part (c), but others were able to gain a mark by using an incorrect value for *r* or by indicating their intended method of "their sector area $-\ \pi r^2$". Premature rounding sometimes led to the loss of the final mark.

Question 6

Most candidates were able to answer parts (a), (b) and (c) and gain full marks. A small minority found the common difference in part (a), used it in part (b) and attempted to use it with the correct formula in part (c). These candidates obviously did not recognise that $|r| < 1$ was a requirement for the sum to infinity. The same was true for the relatively few candidates who found $r = \frac{4}{3}$ in part (a).

Most candidates used the correct summation formula in part (d). Although many of these candidates arrived at the correct answer of $n = 14$, they lost the final mark for incorrect inequality work. A significant number of these candidates were not able to deal with the sign reversals when multiplying $-(0.75)^n$ by -1 or when dividing by $\log 0.75$ which many failed to realise was negative. Those candidates using equalities throughout were generally more successful in gaining full marks. Common errors in this part included candidates who combined $256(0.75)^n$ to give 192^n, and candidates who tried to take the log of a negative number. Some candidates gave their final answer *n* as a decimal, failing to realise that it had to be an integer.

In part (d), a number of candidates used the formula for the n^{th} term starting from $n = 1$, and continued to add each term until arriving at 1000 whilst others used a method "trial and improvement" by using the summation formula. A number of these solutions, however, were incomplete without both the sum of the first 13 terms and the first 14 terms being given.

Question 7

Candidates were generally more successful in answering part (b) than part (a), but it was felt that a significant number of candidates were unsure about solving trigonometric equations and would have benefitted from a more methodical approach of either using a CAST diagram technique or solution curve technique. Although part (a) required answers in degrees and part (b) required answers in radians; this did not appear to be a problem for the majority of candidates.

In part (a), a significant number of candidates did not know how to deal with the 45 in $\sin(x + 45^\circ)$ or with the order of operations to use. A fair number thought that $3\sin(x + 45^\circ)$ simplified to $3\sin x + 3\sin 45^\circ$. Of those who correctly found $\sin^{-1}\left(\frac{2}{3}\right)$, many were then unsure about how to proceed, with some candidates believing that 41.8° was one of the values of x, whilst others subtracted 45 from this answer to achieve -3.2° and at this point could not progress any further. Work to find solutions inside the required range was often muddled, although some candidates were able to find one of the two solutions required for x. Only a minority of candidates were able to find both solutions correctly, but a number of these candidates were penalised 1 mark by offering at least one extra solution in the required range.

In part (b), many candidates were able to correctly substitute $1 - \cos^2 x$ for $\sin^2 x$, and manipulate their resulting equation to find a correct quadratic equation in $\cos x$, with a few candidates either making sign or bracketing errors. It was disappointing, however, to see a fair number of candidates who thought that $\cos x$ could be replaced by $1 - \sin x$ in the initial equation and then went on to attempt to solve a quadratic equation in $\sin x$. Although the majority were able to factorise $2\cos^2 x + 7\cos x - 4$ to give $(2\cos x - 1)(\cos x + 4)$, a minority incorrectly factorised to give $(2\cos x + 1)(\cos x - 4)$. Many candidates went on to solve $\cos x = \frac{1}{2}$ to give $x = \frac{\pi}{3}$, but the second solution sometimes ignored or incorrectly found. A minority of candidates worked in degrees, but most gave their answers in radians in terms of π.

Question 8

In part (a), responses either scored no marks, one mark or all three marks. Those candidates who scored no marks often failed to recognise the significance of the volume. Some tried to calculate surface area, while others failed to introduce another variable for the height of the cuboid and usually wrote down $2x^3 = 81$. It was obvious that many candidates were trying (often unsuccessfully) to work back from the given result. Quite often $\frac{81}{2x^2}$ was simplified to $\frac{162}{x^2}$. A few candidates gave up at this stage and failed to attempt the remainder of the question.

In part (b), many candidates were able to gain the first 4 marks through accurate differentiation and algebra. Mistakes were occasionally made in the differentiation of $162x^{-2}$; in manipulating $12 - \frac{324}{x^3} = 0$ to give $x = \frac{1}{3}$; and in solving $x^3 = 27$ to give $x = \pm 3$. The last two marks of this part were too frequently lost as candidates neglected to find the minimum value of *L*. This is a recurring problem and suggests that some candidates may lack an understanding of what 'minimum' (or maximum) refers to; in this case *L*, and not *x*. This is a common misconception but does suggest that while some candidates have mastered the techniques of differentiation they may lack a deeper understanding of what they are actually finding.

In part (c), a significant number of candidates were able to successfully find the second derivative and usually considered the sign and made an acceptable conclusion. Most candidates found the value of the second derivative when $x = 3$, although a few candidates left $\frac{\mathrm{d}^2L}{\mathrm{d}x^2}$ as $\frac{972}{x^4}$, without considering its sign or giving a conclusion. Occasionally the second derivative was equated to zero, but there were very few candidates offering non-calculus solutions.

Question 9

This question was generally well answered by the majority of candidates. In part (a), the vast majority of candidates eliminated y from $y = -x^2 + 2x + 24$ and $y = x + 4$, and solved the resulting equation to find correct x-coordinates of A and B. It was common, however, to see $x = -5$ and $x = 4$ which resulted from incorrect factorisation. Almost all of these candidates found the corresponding y-coordinates by using the equation $y = x + 4$. A less successful method used by a few candidates was to eliminate x. A significant number of candidates only deduced $A(-4, 0)$ by solving $0 = x + 4$. A popular misconception in this part was for candidates to believe that the coordinates were $A(-4, 0)$ and $B(6, 10)$ which were found by solving $0 = -x^2 + 2x + 24$. A small minority of candidates were penalised 2 marks by ignoring the instruction to "use algebra". They usually used a graphical calculator or some form of trial and improvement to find the coordinates of A and B.

The most popular approach in part (b) was to find the area under the curve between $x = -4$ and $x = 5$ and subtract the area of the triangle. Integration and use of limits was usually carried out correctly and many correct solutions were seen. Many candidates stopped after gaining the first four marks in this part, not realising the need to subtract the area of the triangle. Some candidates lost the method mark for limits as they failed to use their x-values from part (a) and proceeded to use the x-intercepts which were calculated by the candidate in part (b). Candidates either found the area of the triangle by using the formula $\frac{1}{2}(\text{base})(\text{height})$ or by integrating $x + 4$ using the limits of $x = -4$ and $x = 5$. Alternatively in part (b), a significant number of candidates applied the strategy of $\int (-x^2 + 2x + 24) - (x + 4)\,\mathrm{d}x$, between their limits found from part (a). Common errors in this approach included subtracting the wrong way round or using incorrect limits or using a bracketing error on the linear expression when applying "curve" − "line".

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