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Mathematics MPC1

(Specification 6360)

Pure Core 1

Report on the Examination

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General

The paper seemed to provide a challenge for the very able students whilst at the same time the various items that were accessible to weaker students allowed them to demonstrate basic skills such as differentiation, integration, coordinate geometry and rationalising the denominator of surds. Students found this paper much more straightforward than the equivalent paper in Summer 2012.

When a particular form of an answer is required, such as the equation of a straight line, students will not score full marks if their final result is not in the requested form. Careful attention needs to be given to proofs when a printed answer is given, where once again the final line of working should match the printed answer. Poor algebraic manipulation was evident in factorising quadratic expressions and when solving simultaneous equations. Students cannot expect to score full marks for a correct final answer that follows incorrect working.

Some students might benefit from the following advice.

- The straight line equation $y - y_1 = m(x - x_1)$ can sometimes be used with greater success than the form $y = mx + c$
- The only geometrical transformation required for MPC1 is a “translation”
- The tangent to a curve at the point *P* has the same gradient as the curve at the point *P*
- If the remainder is *R* when p(*x*) is divided by *x*+1 then *R* = p(–1)
- A quadratic equation has two distinct real roots when the discriminant is greater than zero ($b^2 - 4ac > 0$)
- A sign diagram or a sketch showing the critical values might be helpful when solving a quadratic inequality.

Question 1

(a)(i) Those who began by substituting $x = 7$ into the equation of *AB* were usually successful. Another approach was to rearrange the given equation in order to find the gradient and then equate this value to the gradient found using the points (–3, 2) and (7, *k*). Quite a few attempted to verify the result by more complicated methods, but such attempts rarely had an appropriate conclusion and did not always convince the examiner.

(ii) Apart from the occasional arithmetic error, this was answered well. A few weaker students used an incorrect midpoint formula, usually having minus signs instead of plus signs.

(b) Once more this was answered well. The most successful students rearranged the given equation to make *y* the subject, but others used the two pairs of coordinates. A few students made sign errors due to the negative coordinates but most students found the correct value of the gradient.

(c) Most students realised the need to find the negative reciprocal of the gradient of *AB* in order to find the gradient of the perpendicular line. Very few failed to do so. However, not all heeded the question where a specific form of answer was requested. A common incorrect answer was $5x - 3y + 7 = 0$ where students, having obtained the equation $y = \frac{5}{3}x + 7$, neglected to multiply the constant term by 3. Those who used $y = mx + c$ for the equation of the straight line usually made more mistakes than those using the form $y - y_1 = m(x - x_1)$.

(d) There were several completely correct solutions here. The question was easier than on previous papers because students did not have to decide which equations to use to find the coordinates of *C*. However, amongst the weaker students, sign and arithmetic errors abounded.

Question 2

(a) The differentiation was almost always correct.

(b) (i) Having only a single derivative to select meant that the success rate in finding the rate of change was greater than some years. Nevertheless, some had difficulty simplifying $\frac{1}{2} - 2$ without a calculator.

(ii) Most students made the correct deduction from their value in part (b)(i) but often the explanations were not clear enough to earn the mark. It was necessary to write something like " $\frac{dy}{dt} < 0$, therefore the height is decreasing", making specific reference to the **negative** value of the derivative.

(c) (i) Once again, the second derivative was usually found correctly, but arithmetic errors sometimes arose when finding the value of $\frac{d^2y}{dt^2}$ when $t = 2$.

(ii) The interpretation of the sign of $\frac{d^2y}{dt^2}$, as indicating whether y had a minimum or maximum value, seemed to be well known.

Question 3

(a) (i) Most students were able to express $\sqrt{18}$ as $3\sqrt{2}$, although a few weaker students were unable to do this correctly. Some completely ignored this part of the question.

(ii) The majority followed the expected method by writing each term as a multiple of $\sqrt{2}$ and most students then simplified their expression to $\frac{2\sqrt{2}}{7\sqrt{2}}$. A surprisingly large number of students left this as their final answer or presented the final answer as $\frac{2\sqrt{2}}{7}$. Another common approach was to multiply by $\frac{\sqrt{18}-\sqrt{32}}{\sqrt{18}-\sqrt{32}}$, but poor arithmetic skills meant that many were unable to simplify $\frac{12-16}{18-32}$ correctly.

(b) Many fully correct answers were seen to this familiar rationalising of the denominator request. The most common error was to not simplify $-2\sqrt{6}+7\sqrt{6}$ correctly in the numerator, with the result often being given as $-5\sqrt{6}$. Some were unable to cope with the product $\sqrt{2}\times\sqrt{3}$, particularly in the denominator, where this was frequently seen as $\sqrt{5}$.

Question 4

(a) (i) Many students were successful in completing the square, although some gave their answer as $(x-3)^2+20$ instead of $(x-3)^2+2$.

(ii) Most students ignored the request in bold type and considered the discriminant of the quadratic. An algebraic approach was expected here, but few made much progress beyond writing $(x-3)^2=-2$. It was necessary to reason that no real square root of -2 exists and therefore the equation has no real solutions. Other acceptable reasoning was based on the fact that the minimum value of the expression $(x-3)^2+2$ was equal to 2.

(b) (i) The term “vertex” is becoming better understood and most students realised that they could write down its coordinates from the completed square form of the quadratic. A few used differentiation to find the stationary point, which was also acceptable.

(ii)Those with the correct vertex usually drew a correct parabola with the value of the intercept on the y-axis clearly shown or stated.

(iii) Many more students are now using the correct term “translation”, but many still used an incorrect word such as “move” or “shift” or also involved another transformation such as a "stretch". The most common, but incorrect, vector stated by students was $\begin{bmatrix} 3 \\ 2 \end{bmatrix}$ and this suggests that they had not read the question carefully enough.

Question 5

(a) Most students attempted to find p(–1) but sometimes sign errors, usually from poor use of brackets, prevented students from finding the correct remainder. Those who attempted to find p(1), or who simply used long division, scored no marks for this part.

(b)(i) Although there were still some who thought that the Factor Theorem involved long division, the vast majority found p(3) and showed sufficient working to verify that p(3) = 0. There was still a significant number who failed to include a concluding statement such as "therefore x – 3 is a factor" and these students did not score full marks.

(ii) The majority used long division or inspection to find the quadratic factor and then successfully factorised to be able to express p(x) as a product of linear factors. The repeated factor seemed to disturb many students who felt that the factorised form must be something like (x – 3)(x –2)(x + 3).

(c) A generous method mark was awarded for drawing a recognizable cubic curve. Those with the wrong factors usually earned this mark. Those with the correct factors were sometimes unsure of the correct shape of the curve in the vicinity of x=3. It was pleasing to see many good sketches, but these were occasionally spoiled by not marking the values –2 and 3 on the x-axis or by poor curvature beyond x = 3 or before x = –2.

Question 6

The different format of this question took many students by surprise. Many weaker students were confused about the processes required. Some even used integration in part (a) and gradients in part (b) or thought that they were required to find the normal and the tangent in the two parts.

(a)The majority realised the need to substitute x = 1 into the given expression for $\frac{dy}{dx}$, but even that was not always evaluated correctly. Quite a few differentiated the given expression and scored no marks at all. Although most went on to find the equation of the tangent in the required form, a substantial number found the normal instead. Others hedged their bets by finding the equations of both the tangent and the normal, with no indication as to which was which. It was disappointing to see that several students, who obtained a correct equation for the tangent in the form y – 4 = 9(x –1), were unable to simplify this correctly to the form y = 9x – 5.

(b) When integration was attempted, it was usually done correctly with just the odd mistake in signs or coefficients. However, many failed to include the constant of integration, " + c" , and could proceed no further. Many who did have the " + c" stopped at that point. Some substituted x = 1 into their expression for x and equated this to zero. This could not be given any credit because they did not have an expression of the form y = …. and so were unable to substitute y = 4. Many of those who found the correct value of the arbitrary constant failed to write the final equation in the form y = f(x).

Question 7

(a) Many students began by trying to complete the square for both the x terms and the y terms. These students, in an attempt to put x=0, often simply wrote $(y-2)^2 = 12$ and scored no marks. A surprisingly small number of students substituted x = 0 directly into the original equation; those who followed this method sometimes stopped at $y^2 - 4y = 12$, apparently being unable to solve the quadratic equation; others concluded that " y = 12 *or* y – 4 = 12", which is a bad error and not really expected at this level of mathematics. Those trying to solve $(y-2)^2 = 16$ tended to miss the negative square root of 16.
Students who found that the radius was 5 sometimes used a diagram with a right angled triangle, two of the sides being 3 and 5. This enabled them to find the y-intercepts using the y-coordinate of C , by writing $y = 2 \pm 4$.

(b) In their working for the previous part, many had already established the equation of the circle in the form $(x + 3)^2 + (y – 2)^2 = 25$ and could write down the value of the radius. However, the correct method was in doubt when 25^2, or $\sqrt{25}$, instead of 25, appeared on the right hand side of the student's equation, even though in each of these cases the radius was then stated as being 5.
A significant number of students, despite the coordinates of the centre being given in the question, wrote down an incorrect circle equation such as
$(x – 3)^2 + (y + 2)^2 = 25$ and once again concluded that the radius was equal to 5. Students cannot expect to score full marks for any answer that follows incorrect working.

(c) (i) Although most students recognised that they should use the distance formula, many added 25 and 9 to make 36 not 34. There were also many examples of poor notation, such as $5^2 + 3^2 = \sqrt{34}$. There were many arithmetic slips due to the negative coordinate of C. Those who used an incorrect formula for the length of CP scored no marks at all.

(ii) Some realised that (2, 2) was one of the points of contact and then found PQ very easily. Failing to recognise the position of the right angle often led to many students writing $\sqrt{34+25}$ for the length of PQ. Many, who perhaps believed that they were using Pythagoras correctly, wrote $\sqrt{34} - \sqrt{25} = \sqrt{9}$ and this scored no marks, even though students obtained the correct value for the length of PQ. The mention of "tangent" often triggered attempts to find equations rather than using the geometrical properties of the circle.

Question 8

(a) Students must be aware that, when they are asked to complete a proof, each stage must be clearly and accurately shown. This was not always the case, and careless sign errors and the omission of "= 0" were penalised.

(b)(i) A very common error here, in finding the discriminant, $b^2 - 4ac$, was where students explicitly wrote " $b = 2x+1$ " instead of " $b = -(2x+1)$ ". Those who did have the correct value of b sometimes wrote b^2 as $-(2x+1)^2$. Unfortunately, many students did not write the condition for distinct real roots until the very last line which was insufficient, since this was the given answer.
The better solutions began by quoting the condition that two distinct real roots occur when $b^2 - 4ac > 0$ or the appropriate inequality with the discriminant expressed in terms of k.

(ii) It was pleasing to see some completely correct solutions here. Those who chose to factorise the equation, in order to find the critical values, were usually more successful than those using the quadratic equation formula, as $\sqrt{20^2 - 16x9}$ defeated many without the use of a calculator. Students are advised to draw a sketch or sign diagram in order to solve a quadratic inequality. A few thought that the two inequalities, $k < \frac{1}{2}$, $k > \frac{9}{2}$ should be combined and so spoiled their correct solution by writing something like $\frac{1}{2} > k > \frac{9}{2}$ as their final answer, and this was penalised.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website: http://www.aqa.org.uk/over/stat.html

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.

UMS conversion calculator www.aqa.org.uk/umsconversion