AS

Mathematics

7356/2

Report on the examination

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General

It is pleasing to note that the standard of responses from students this year was much improved from last year. This was reflected in the significant increase in the mean mark for the paper. The 2025 paper was more accessible than the 2024 paper, perhaps helped by having an extra 4 questions, but the general feeling was, that students seemed better prepared, and it is possible that the 'covid effect' is having much less of an impact than it did in previous years.

There were excellent responses to all of the multiple-choice questions. The algebraic skills seen in Section A were more precise and accurate than in previous years, which enabled students to make much further progress in questions such as Q4, Q5, Q6 and Q7a which were really well done. In Section B, excellent work was seen in most of the questions in particular Q15, Q16, Q17, Q19 and Q20.

The use of calculators continues to develop and the calculators are becoming more sophisticated; but it is important that students remember that if a question asks for an answer to be 'fully justified'; then a quick calculator solution, with no working, even if correct, will not be credited with any marks.

It is important that students try to keep their responses within the lined areas of the booklet where possible. There are additional blanks sheets that can be used at the back of the booklet, if using these, please label carefully which question and part the extra work refers to.

Question 1

This question required the identification of the curve $y = (x + a)^2$ where a was a positive constant. Finding the point where the curve cut the x-axis, i.e. where $x + a = 0$, led to the coordinate $(-a\ , 0)$. The only curve containing this coordinate was the fourth option which was correctly identified by around 60% of students.

Question 2

This question was very well answered, with around 90% of students correctly choosing the second option $6x$ as $f''(x)$ by differentiating the given $f'(x)$, this notation was clearly well known to students.

Question 3

This question required a clear and logical approach. Firstly, the area of the triangle could be deduced from the length of the prism and its volume.

Area of triangle $ABC = \dfrac{500}{20} = 25$

The angle CAB could then be found using $\dfrac{1}{2} \times 10 \times 6 \times \sin A = 25$

Leading to $\sin A = \frac{5}{6}$. A significant number of students stated the final angle as 56.4°, but the question stated that the angle was obtuse, so it was necessary to subtract from 180° to obtain 124° (to the nearest degree)

Question 4

In (a) the vast majority of students were able to correctly identify $-\frac{2}{3}$ as the gradient of the line after rearrangement, a few sign errors were noted.

There were many different methods that students used to find p = 10 in (b)(i)

- The line AB was perpendicular to L, so its gradient could be found from (a). The gradient between the points A and B could then be used to set up an equation to solve for p
- The equation of the line AB could be found using the perpendicular gradient to the line L along with the coordinate A(2 , -2). The coordinates of the point B could then be substituted into this equation to find p
- The midpoint of AB could be found $\left(6\,,\,\frac{p-2}{2}\right)$ and these coordinates substituted into the equation of the line L to find p

In (b)(ii) any value of p calculated in (b)(i) was carried forward to this part and if correctly substituted into $\left(6\,,\,\frac{p-2}{2}\right)$ was given the mark. Using p = 10, gave the midpoint as (6 , 4)

Question 5

This question was very well done with over 66% of students obtaining full marks.

The vast majority of students successfully used the given substitution to obtain the correct quadratic equation in terms of u.

Solving $16u^2 - 33u + 2 = 0$, by factorisation or calculator, gave $u = 2$ or $u = \frac{1}{16}$. Unfortunately, some students thought erroneously, that these were the final values of x and so made no further progress.

A substitution back for u gave $4^x = 2$ or $4^x = \frac{1}{16}$, from which x could be stated using indices or logs. The final values being $x = \frac{1}{2}$ or $x = -2$

Question 6

There was some pleasing algebra seen in this question, with just under half of all students able to go on and achieve full marks. This was a 'fully justify your answer' question, so full working was required.
There were two possible substitutions that could be made:

- Replacing y as $2x^2-4x+1$ which gave the equation $x=2(2x^2-4x+1)-11$ to solve
- More challenging was to substitute $x=2y-11$ which gave the equation $y=2(2y-11)^2-4(2y-11)+1$ to solve.

Many students found difficulty correctly simplifying the quadratic in y, whereas the students who replaced y in terms of x generally made good progress.

A number of students lost marks because they did not rearrange their quadratic into the form f(x) = 0 or f(y) = 0. Equations such as $x=4x^2-8x-9$ or $y=8y^2-96y+287$ were seen, and, unfortunately, students then tried to solve the right hand side of the equation as though that was the required quadratic, this led to answers involving surds using the quadratic formula.

A clear substitution of at least one value back into either equation was then required. On this occasion the final x and y values stated were accepted, with no requirement to pair them up correctly. The solutions were $x=3, x=-\frac{3}{4}$ and $y=7, y=\frac{41}{8}$

Question 7

The first part of this question required students to express f(x) in the form $a(x+b)^2+c$. Most attempts used completing the square to do this, but equating coefficients was seen. Over 50% of students correctly identified a = 3, $b = \frac{1}{2}$ and $c = -\frac{35}{4}$. The main error noted was an arithmetic error leading to an incorrect value for c.

In (b)(i) many students confused finding the minimum value of $3\sin 2\theta + 3\sin\theta - 8$ with finding the minimum point of the curve $3\sin 2\theta + 3\sin\theta - 8$. Only a value of $-\frac{35}{4}$ was accepted.

In (b)(ii) students had to use $(x+\frac{1}{2})^2$ from (a) and recognise that the minimum value of $3\sin 2\theta + 3\sin\theta - 8$ occurs when $\sin\theta + \frac{1}{2} = 0$, i.e. $\sin\theta = -\frac{1}{2}$. The smallest positive solution was $\theta = 210^\circ$

Question 8

The vast majority of students were able to pick up some marks on this question. As a 'fully justify your answer' question, a number of things were required:

- To differentiate the equation of the curve to obtain $\frac{dy}{dx}$
- To state that at a stationary point $\frac{dy}{dx} = 0$
- To set $\frac{dy}{dx} = 0$ before solving the equation (although on this occasion the omission of this was condoned as long as both x values were correctly obtained
- To test for the nature of the stationary points, using $\frac{d^2y}{dx^2}$ or alternative methods, for both x = 4 and $x = -\frac{2}{3}$ to clearly identify the unique minimum point
- To show a clear substitution of at least x = 4 into the original equation to find the corresponding y- coordinate
- To state the minimum point as (4 , −46)

Any correct answer without any working received no credit.

Question 9

This was a different style of question which could be tackled using the properties of integrals along with transformations of curves. Part (a) was well done, with (b) and (c) less so.

In (a) $\int_1^3 2f(x)dx$ = $2\int_1^3 f(x)dx$ = 2 × 8 = 16 or identifying a stretch scale factor 2 in the y-direction of f(x) which enabled the same conclusion to be stated.

In (b) $\int_1^3 [f(x)+2]dx$ = $\int_1^3 f(x)dx + \int_1^3 2dx$ = 8 + 2[2] = 12 or identifying a translation of $\begin{bmatrix} 0 \\ 2 \end{bmatrix}$ of f(x) which again led to 8 + 2[2] = 12

In (c) f(x – 1) is a translation of f(x) by $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ so $\int_2^4 f(x-1)dx \equiv \int_1^3 f(x)dx$ = 8

Question 10

In part (a) to show the given result it was necessary to rationalise the denominator of the fraction. This could be done by multiplying by $\frac{\sqrt{k}-\sqrt{k+1}}{\sqrt{k}-\sqrt{k+1}}$ or $\frac{\sqrt{k+1}-\sqrt{k}}{\sqrt{k+1}-\sqrt{k}}$. A clear multiplication of the brackets on the denominator was then required. This gave either $k-(k+1)$ = −1 or $(k+1)-k$ = 1. The required result then followed.

In part (b) it was clearly stated to 'use the result from (a)', so any correct answers without evidence of using (a) was given no credit. Using the result from (a) gave

$\dfrac{1}{\sqrt{1}+\sqrt{2}}+\dfrac{1}{\sqrt{2}+\sqrt{3}}+\dfrac{1}{\sqrt{3}+\sqrt{4}} = \left(\sqrt{2}-\sqrt{1}\right)+\left(\sqrt{3}-\sqrt{2}\right)+\left(\sqrt{4}-\sqrt{3}\right)$

$= \sqrt{4}-1$

$= 2 - 1$

$= 1$

Students who left their answer as $\sqrt{4}-\sqrt{1}$ or $\sqrt{4}-1$ lost a mark.

Question 11

This question combined the use of the discriminant of a quadratic along with inequalities. Over 37% of all students achieved full marks on this question.

Students demonstrated their knowledge of the discriminant by stating that for two distinct real roots: $b^2 - 4ac > 0$

It was then necessary to simplify and rearrange this inequality into the form f(k) > 0, although on this occasion f(k) = 0 was also accepted.

Using the discriminant correctly gave $(2k-1)^2 - 4(1)(4-2k) > 0$

This then led to the quadratic inequality $4k^2 + 4k - 15 > 0$

There were a number of careless errors noted in getting to this inequality, such as:

- $-4(1)(4-2k) = -16 - 8k$
- $(2k-1)^2 = 2k^2 - 4k + 1$
- $(2k-1)^2 = 4k^2 - 4k - 1$

The critical values could then be found as $k = -\dfrac{5}{2}, k = \dfrac{3}{2}$ from which the correct range of values of k could be stated as $k < -\dfrac{5}{2}$ or $k > \dfrac{3}{2}$

It was not acceptable to quote these two separate ranges as a single range of values.

Question 12

It was very surprising in (a) how tricky some students found this 1-mark question, with many attempts poorly set out and not providing clear evidence of showing the given result. From triangle ABC, $\cos\theta = \dfrac{12}{AC}$ which rearranges to the given result $AC = \dfrac{12}{\cos\theta}$

In (b) working in triangle AB, $\cos\theta = \dfrac{AD}{12}$ from which $AD = 12 cos\,\theta$

In (c) it was required to show that $CD = \dfrac{12 - 12\cos^2\theta}{\cos\theta}$; most students were able to make a start by writing $CD = AC - AD = \dfrac{12}{\cos\theta} - 12\cos\theta$, it was then necessary to see two separate fractions with a common denominator $\dfrac{12}{\cos\theta} - \dfrac{12\cos^2\theta}{\cos\theta}$ leading to the given result.

There were many pleasing responses to (d), with 39% of all students achieving full marks. The given result from (c) could be used to state that:

$$8\sqrt{3} = \frac{12 - 12\cos^2\theta}{\cos\theta}$$

Rearranging this gave a quadratic equation in $\cos\theta$, $12\cos^2\theta + 8\sqrt{3}\cos\theta - 12 = 0$

Solving this equation gave $\cos\theta = \dfrac{\sqrt{3}}{3}$ or $-\sqrt{3}$

A number of students did not fully justify why $-\sqrt{3}$ needed to be discarded. Simply crossing $-\sqrt{3}$ out is not sufficient. Statements such as not valid, out of range for $\cos\theta$ or equivalent were accepted. Solving $\cos\theta = \dfrac{\sqrt{3}}{3}$ gave $\theta = 55°$

Section B Statistics

Question 13

This question was well done with around 84% of students identifying $\dfrac{36}{200}$ from the two-way table, leading to a probability of 0.18

Question 14

The result for independence between two events was well known with 82% of students correctly identifying 0.15 as the correct probability from 0.25 × 0.6

Question 15

Using the area property of histograms allowed two areas to be compared to find the value of k.

- For $10 < x \leq 30$ frequency = 20 × 0.7 = 14
- For $30 < x \leq 35$ frequency = 5 × k = 5k

So, from this 5k = 2(14) = 28

Giving $k = \dfrac{28}{5}$

Question 16

Finding an unknown probability from a discrete probability distribution continues to provide a good source of marks with around 80 % of students obtaining p = 0.075. Some careless errors in combining the probabilities were seen.

Question 17

The outlier A from the scatter diagram was recognised by the vast majority of students.

In (b) the outlier being removed would make the correlation more negative. Any phrase equivalent to this was accepted.

In (c) it was necessary to describe the correlation in context, statements such as 'negative correlation between raincoat sales and windspeed' or 'as windspeed increases sales of raincoats decrease' or 'as windspeed decreases sales of raincoats increase' were accepted.

It was necessary in (d) to state the claim was not valid along with a valid reason such as a scatter diagram cannot prove causality, as there could be other factors which are causing the drop in sales.

Question 18

This question on the binomial distribution proved to be more challenging than anticipated. In (a) there were three possible assumptions in context that were accepted:

- One battery being faulty is independent of any other battery being faulty
- Two possible outcomes, a battery is faulty or not faulty
- The probability of a battery being faulty is constant at 3%

Stating that probabilities are independent was not accepted as an assumption.

Using the calculator enabled most students to get the correct probability for (b)

The probability found in (b) was needed to form a new binomial distribution B(10 , 0.2575) in (c). This distribution could then be used to find $P(X \leq 2) = 0.772$

Question 19

This question was based upon the Large Data Set. In (a) the number of electric cars in the distribution corresponded to the number of cars with zero CO_2 emissions, which was 1 car.

It was thought that parts (b) and (c) would be the straight forward use of the calculator to find the mean and standard deviation of the distribution, unfortunately this did not prove to be the case, as only 64% found the correct mean of 48 and under 53% found the correct standard deviation of 20.9.

In (d) it was not valid to make the comparison because there were no electric **and** no electric/petrol cars in the 2002 data. Both types of propulsion had to be identified to score the mark.

Question 20

Students were able to confidently find the probability that all 4 lights were red in (a), calculating $0.54 \times 0.6 \times 0.7 \times 0.8 = 0.181$

In (b) there were four possible ways that exactly one light could be red. Four calculations were required, each time changing the light that was red, whilst keeping the other three non-red. Just under half of all students were able to obtain the correct answer of 0.0994. Errors noted included over-rounding giving the answer of 0.1, without stating 0.0994, and finding two reds or three reds rather than the required one red.

Question 21

There continues to be improvements in the quality of the solutions to hypothesis tests for the proportion p.
The initial hypotheses H_0: $p = 0.8$ and H_1: $p < 0.8$ were generally correctly stated. Once H_0 was defined, the appropriate distribution to be used a B(60 , 0.8) could be stated. As 42 people described their experience as 'excellent', it was required to calculate $P(X \leq 42) = 0.0427$.
This probability could then be compared to 0.05 (as a one-tailed test) and to reach the conclusion that H_0 is rejected. Finally, a full conclusion in context was required for the final mark.

Errors noted included:

- Using the sample proportion of 0.7 for the value of p, in H_0
- Poor notation in H_0 and H_1, using x or $\overline{x}$ for p
- Finding $P(X = 42)$ or $P(X \leq 43)$ or $P(X \leq 41)$
- Stating H_0 accepted because $0.0427 < 0.05$
- Not including the word 'proportion' in their conclusion
- Working with the mean of 48

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.