AQA
Questions matter

A-level
Mathematics
7357/2

Report on the examination

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General

Students again showed sound understanding and knowledge of most of the topics examined and this year they performed slightly better in the pure mathematics section than in the mechanics section.

The understanding that a moment is a force x distance was much better this year, with over half of all students able to score at least three out of four However, this question did require answers to be given to the correct rounding accuracy and the inclusion of units to score full marks. About two thirds of those who scored three marks failed to get the final mark.

Please ensure that round answers in the mechanics questions are rounded to the same number of figures as the acceleration due to gravity stated in the question. Furthermore, ensure units are written in all parts.

The number of numerical and sign errors made by students this year continues to be a big problem in causing marks to be lost, and students are reminded to check numerical calculations with their calculators. Use of calculators when completing ‘find’ style questions is marked positively.

Questions with the command words ‘show’, ‘prove’ or where students are asked to ‘fully justify’ their response continue to be areas where the final marks are not achieved by many. Students are reminded that all workings should be shown in these parts. Reasoning should be included as to why you are following a particular line of working is being followed and often a concluding statement is required to ensure you show you fully understand what has been requested of you. Please ensure full sentences are used and not just one-word responses such as ‘rest’, as was often seen in question 13(a).

Students writing many reasons where only one was requested was seen less this year and it was clear that many had taken heed from last year’s examiners report. As this is still occurring, it is worth pointing out that examiners are to, ‘withhold marks for final accuracy and conclusions if there are conflicting complete answers or when an incorrect solution (or part thereof) is referred to in the final answer,’ under the ruling of choice in the mark scheme. For example, if a part reads, ‘state an assumption…’ give <u>one</u> assumption.

Section A Pure Mathematics

Question 1

This question performed as an easy opener for most with almost 90% of students correctly choosing the first option.

Question 2

Nearly three-quarters of all students chose the correct response for this question, the top-left one.

Question 3

Just over 50% of students identified the second option as the correct solution in set notation. The final two options were least commonly chosen options, which showed a good understanding of the correct brackets to use with set notation.

Question 4

Students completed this question better than last year's logarithm question with about 80% of students scoring full marks, and less than 10% unable to score any marks.
Last year students lost marks for attempting too many steps in one go, this was observed less this year.

The most common fully correct method on this question was to begin by taking log of base five of both sides and then applying the log law, $\log a^b = b\log a$, as shown in the typical solution. Roughly 10% of students failed to score the second mark after achieving the first mark.

The most common reason for this was for failing to correctly deal with the one and writing the final answer as $x = \log_5 20 - 1$.

Question 5

This question was performed well on, with 80% of students achieving at least one mark and most going on to score full marks. The final mark was often lost due to mistypes into calculators.
The most common approach here was to use $\frac{\theta}{2\pi} \times \pi r^2$ before cancelling out pi.

Question 6

Nearly all students were able to find the missing y-value in part (a)(i) and write it to the same accuracy as the values in the table or better.

In part (a)(ii) nearly all students were able to either work out the correct h value or show $7.3891 + 10.9196 + 2(6.124 + 6.3249 + 7.2155 + 8.7139)$ correctly.

Most students used the trapezium rule formula, which is printed in the formulae booklet. However, students mainly lost the final mark for failing to use the correct number of brackets in their expression for the area.
If 30.026 was not achieved, then the method mark could only be awarded with clear substitutions seen.
Simply copying the formula or writing $\frac{h}{2}[y_0 + y_6 + 2(y_{\text{middles}})]$ or similar is not enough to score marks.

In part (b) over 60% of students were able to state that the student was incorrect as the trapezium rule was an overestimate. However, less than 25% were able to fully reason this using the concavity of the curve.

Question 7

In part (a) nearly all students were able to substitute in the given values correctly. We allowed students to show this with evaluated terms due to the expectation of knowing the values of five squared and cubed at GCSE. Normally students would be required to show values substituted explicitly and we did withhold a mark in part (b) if this was not shown.
Most students went on to score full marks in part (a). The main reason for the final mark being withheld was when students jumped straight from the first or second line of our typical solution to the given equation. Show that questions often require some intermediate work by students to gain the final mark.

In part (b) most students scored at least two marks. About 10% of these students failed to score full marks, as previously stated, for not showing an explicit substitution of '-5' for *x*.

Nearly all students were awarded the mark in part (c).

In part (d) Nearly 90% of students were able to understand what was required and gained one or two marks. Roughly half of the students who scored two marks were unable to achieve the final mark as they did not fully justify that stationary points occur when $\frac{dy}{dx} = 0$.

Question 8

Students were far more successful in this question when they worked in terms of $\sec x$ and $\tan x$ compared to those attempting to work with fractions.

Roughly 80% of all students were able to recall that $\sec^2 x - \tan^2 x = 1$ in part (a).
Over 80% of students were able to gain at least two marks on part (b). However, too many efforts were full of numerical errors. The mark scheme allowed students to achieve the third mark even with some numerical errors if they showed one of the required evaluations.

Please note the way in which the mark scheme differentiates between the third and fourth mark. Students were expected to convert either one or both of their $16\sec x \tan x$ terms to the same format for the fourth mark but simply had to have two correct equivalent terms evaluated to zero, or both removed from their expressions to achieve the third mark.

Nearly 70% of students scored three marks and more than 50% scored full marks on this part.

Students who converted their terms to fractions with the denominator $\cos^2 x$ often incorrectly treated their expression as an equation equal to zero and then attempted to multiply both sides by $\cos^2 x$.

Nearly two-thirds of students gained the mark in part (c), it is worth noting that answers in radians scored zero on this part. Please work in the given angle format on a question.

Question 9

Nearly all students were able to identify the correct coordinates of C in part (a), and roughly 90% were then able to use this answer and the radius to state the correct coordinates in part (b).

In part (c) the 'fully justify your answer' here required a full mathematical argument rather than a statement, I will add that some very nice statements of reasoning were seen by examiners.
Over 90% of students were able to begin a correct approach to this question and most of those were able to use this approach to gain the second mark.
The third mark was often lost through one of the following reasons:

- Choosing 18 and not realising that this was the *x*-coordinate of B.
- Not solving the question and writing that $a = 6$ or giving the answer in the form (6, 10)
- Using an approach involving Pythagoras' theorem to get a side length of 6 for the horizontal edge of their right-angled triangle and not fully justifying the argument by then stating that $a = 12 - 6 = 6$. We needed to see a differential between the side length of 6 and the x -coordinate of 6.

Question 10

In part (a) roughly 80% of all students were able to gain at least two marks with nearly 50% scoring full marks. Those scoring two marks often achieved the first and the third mark. A common mistake seen on this question was believing that the product rule is: vu' – uv' or v'u – u'v, which we condoned in the first mark this year.
The final mark required students to write the equation $\frac{dy}{dx} = x^{k-1}[1 + k\ln x]$ and not simply an expression, over 20% of students who achieved three marks did not achieve the final mark because of this.

Part (b) had the command 'fully justify your answer'. To be awarded the final mark students were required to show a complete mathematical argument with some intermediate simplification.

There was also an E1 mark for a correct reason for rejecting $x = 0$. Students simply had to use the given domain in the question to gain this mark. Alternatively, students could reason that if $x = 0,\ \ln x$ is undefined.

A nice alternative approach when finding the y-coordinate was sometimes seen using the fact that $\ln x = -\frac{1}{k}$ from earlier in the question and this was awarded full marks, if all other criteria was met.

Nearly 70% of students were able to substitute the given coordinates into the original equation and achieve the required answer. Over 10% of students left this part blank.

Part (d) was one of the lowest scoring parts of the exam, which is to be expected as it was challenging. If a student had correctly reasoned k = 1 in part (c) the marks were far easier to achieve.
Students were able to score the first mark by correctly differentiating the given gradient function, and could still include A and k.
To get the second mark $\frac{d^2y}{dx^2} = \frac{1}{x}$ had to be obtained.
The final mark was achieved by roughly two-thirds of students who obtained $\frac{d^2y}{dx^2} = \frac{1}{x}$.
The two most common reasons for missing out on the R1 mark was for either just stating $x \neq 0$ and not referring back to $\frac{1}{x}$ or for only showing that there was not a point of inflection at $\left(\frac{1}{e}, -\frac{1}{e}\right)$ rather than proving there was no point of inflection at all.

Section B Mechanics

Question 11

Over 90% of students were able to correctly identify 0.32 as the correct coefficient of friction.

Question 12

Over 80% of students were able to correctly identify 0 as the correct displacement.

Question 13

Over 90% of students were able to achieve the first mark In part (a). However, any student using u = 0 and verifying the value of one of the other constant acceleration terms did not score a mark on this part.

To gain the final mark, students had to show one intermediate step before showing that the initial velocity (or the square of it) was zero, and they also had to conclude that the car started from rest. Any equivalent statement was acceptable here.

Some students simply wrote the word 'rest'. This was not acceptable. A full sentence is always required when concluding at the end of a question.

In part (b) nearly 70% of students were able to give a correct reason as to why the model would fail. Students were able to either just state that it was unlikely the acceleration was going to remain constant, or they had to put a contextual reason as to why the model would fail. The car would run out of fuel was the most common correct answer.

Some students misunderstood this question and said things along the lines of 'the road would no longer be 225 metres' or 'the car would no longer be travelling at 30 m s^{-1}', answers had to explain why the model failed after point B and not before in order to score the mark.

Question 14

Question 14 required students to work correctly with vectors. The most commonly approach was to find the velocity in the y-direction for the arrow and then find the magnitude of this and 40 to find the final speed of the arrow giving their answer, anything which rounds to 48.

A common incorrect approach was to find the magnitude of the speed of the arrow at the start and then use this scalar in a vector equation with gravity and displacement in the y-direction. This approach scored zero marks.

Some students used the conservation of energy equation. If this method was fully reasoned, full marks could be given. However, it had to be fully reasoned. It must be pointed out that such a method is not expected, nor listed in the specification.

It's worth noting that in this part that students were required to have consistent signs for initial velocity, acceleration, and displacement. However, we condoned students using the positive square root for their velocity when finding the speed as students often know that when they are finding the magnitude, they're squaring the velocities, so signs don't matter.

Question 15

In part (a) the most common correct approach was to resolve horizontally and vertically before finding the magnitude of their two components. In this part, incorrect signs for components were not condoned.

Where students incorrectly evaluated their components, they could still gain the third mark, but both accuracy marks were unavailable. For example, students could put $17-26\cos(40)=-2.917...$ or $26\cos(40)-17=2.917...$, but they could not write $26\cos(40)-17=-2.917...$ and get the accuracy marks.

Over two thirds of students were able to get one mark on this question and nearly 50% went on to score full marks.

In part (b) we allowed students to find the obtuse or reflex angle either side of the two forces.

Students struggled in this part with just over 40% achieving the first mark and the only one quarter of students achieving full marks, even with the allowance of rounded components within an appropriate trigonometric equation.

In part (c)(i) students had to understand that for forces to be in equilibrium, the resultant of all forces is zero so the new force must be 17 newtons. As the request was for the magnitude of the force then -17 was not awarded the mark.

Part (d) required students to recall what a bearing is and required them to have parts (b) and (c) correct. Therefore, 100 degrees was the only answer allowed here. This mark was only achieved by roughly 20% of students.

Question 16

In both parts of question 16 it was unfortunately too common to see the mix up between sine and cosine. Interestingly weight was incorrectly seen as $\frac{10}{g}$ more than in previous years.

Students are reminded that we represent Newton's second law of motion using $\boldsymbol{F} = m\boldsymbol{a}$.

In 16(a) students had to resolve parallel to the slope and form a three-term equation. Students who used an equation of motion method with acceleration equal to zero were allowed three terms equated to zero. Almost 40% of students achieved at least three marks.

In this question most students who set up a correct equation were able to achieve full marks; some lost the marks due to poor rearranging or using 30 in radians instead of degrees.
The two most common loss of marks here were:

- Involving the normal reaction and adding a friction force as an extra term, using the coefficient of friction 0.2 from the next part.
- Failing to resolve the components of weight and/or tension and just using 10g and T.

In part (b) the same issue occurred with students failing to resolve the components of weight and tension, but this occurred less. The most common loss of marks here was for failing to include the perpendicular component of tension when trying to find the magnitude of the normal reaction between the sledge and the slope. This mistake lost three of the seven marks.
This year we required students to not only recall the model for friction, but they had also to use $\mathbf{F} = \mu\mathbf{R}$. This could have been as simple as $\mathbf{F} = 0.2\mathbf{R}$.
Nearly 85% of students scored at least one mark in this part and almost 30% of students scored full marks.

Less than one quarter of students were able to state that the sledge is modelled as a particle in part (c). This question required students to give a modelling assumption that had been used in both parts. The most common incorrect answer was: ‘The rope is light and inextensible,’ which had already been stated in the question. Other assumptions given were only relevant to one part and not both.

Question 17

Over 80% of students were able to find the required vector in part (a)(i). Numerical errors were the biggest issue here followed by students incorrectly thinking that $\overrightarrow{AB} = \overrightarrow{OA} + \overrightarrow{OB}$ instead of $\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA}$. Students are reminded that a vector diagram is very useful here.

Part (a)(ii) was more successful due to the inclusion of the follow through from (a)(i), with over 85% of students achieving this mark. Students are reminded that when they are finding the magnitude of a vector to use brackets carefully on their calculator if you are inputting a negative number that is to be squared.
If you input -3^2 your calculator will correctly work out -9 due to it following the correct order of operations.
To get this mark you would need to type $\sqrt{8^2 + (-3)^2 + (-1)^2}$, alternatively the negative signs can be excluded when a number is being squared as it gives the same result; $(-3)^2 = 3^2$.

Part (b) had the command words 'show that' and thus required students to show us both required vectors and magnitudes.
As it also included the word 'hence', students who only wrote the vectors for sides AC and BC and their magnitudes were not penalised.
If students failed to show any vectors the second method mark was the only mark available.

Almost 50% of students achieved at least three marks. The final mark was lost by nearly 20% of students due to either:

- Incorrectly equating a length to a vector. Please ensure notation is checked.
- Not including a conclusion or for including incorrect information in the conclusion.

The most common incorrect reason was that a scalene triangle must not include a right-angle. Students are reminded that a scalene triangle has three different side lengths and thus three different angles. The Pythagorean triple 3, 4, 5 is an example of a right-angled, scalene triangle.

Question 18

It was very pleasing to see students perform so well in a question involving moments!
In part (a) nearly two thirds of students achieved three or four marks. The difference in success in this question seemed to be that the question directed students to take moments about A.

Students were also much better at including gravity this year and showing a moment as force x distance.

More than half of the students who scored three marks failed to achieve the final mark as this mark required students to round their answer appropriately and include units.

One of the assessment objectives we must test is:

AO3.2a	Interpret solutions to problems in their original context

This is often tested in the mechanics section of paper 2. I want to remind students that when we tell you which value of gravity to use you are expected to round your final answer to that accuracy as well. This will only be checked once but it is safest to apply this throughout the whole mechanics section. E.g.

- If g = 10 m s $^{-2}$, you round your final to one significant figure.
- If g = 9.8 m s $^{-2}$, you round your final to two significant figures.
- If g = 9.81 m s $^{-2}$, you round your final to three significant figures.

You should also be including units with all your answers.

(b)(i) was quite successful with over 60% of students understanding that as the distance between the pivot and child decreased then the clockwise moment decreased and in turn the reaction force at B would decrease as the platform is in equilibrium. Some students incorrectly stated that it would decrease to zero, forgetting the weight of the platform.

(b)(ii) was only correct answered by just under 25% of students. The correct answer that the tension remained the same in the chain was due to the child being at the pivot point.
If you take moments about B with and without the child on the platform you would have the same tension in the chain.

Question 19

Just over 90% of students got one mark in part (a) with most then getting full marks. An omission of a coefficient from the displacement equation was the most common reason for losing the accuracy mark.
Very few candidates attempted to use constant acceleration formulae in this part.

In part (b) students had to integrate the given expression for acceleration to find an expression for velocity before using the initial conditions correctly to score the first three marks. Students failing to use the initial conditions could only score at most three marks, this was omitted in about 10% of responses where integration was used.
Most students understood that t = 2 had to be substituted in this question. This had to be into expressions for velocity and must come from use of calculus to be awarded the mark.
There were a surprising number of responses where students correctly used calculus in (a) but then used constant acceleration formulae in (b), around 10% of students who got full marks in (a) did this.

Nearly one third of students scored full marks on this part.

Some students struggled correctly identified $\mathbf{v}_p = 2\mathbf{v}_q$ or $0.5\mathbf{v}_p = \mathbf{v}_q$ but failed to get to q = 28. This was often due to not knowing where to put the 2 or 0.5 in their equation.
Once you've identified $\mathbf{v}_p = 2\mathbf{v}_q$, using the $\mathbf{i}$ components, you need to substitute the $\mathbf{j}$ components from $\mathbf{v}_p$ and $\mathbf{v}_q$ into the equation $\mathbf{v}_p = 2\mathbf{v}_q$.

This is the process in full:

$$8 + q = 2(18)$$
$$8 + q = 36$$
$$q = 28$$

Mark Ranges and Award of Grades

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