A-LEVEL
MATHEMATICS

7357/2: Paper 2
Report on the Examination

7357
June 2022

Version: 1.0

General Comments

This paper saw nearly the full range of available marks scored and gave all students the opportunity to demonstrate their knowledge and skills. There were plenty of marks available for completing routine tasks with opportunities for real stretch and challenge at the top end.

Performance was slightly stronger on the first half of the paper, but it was encouraging to see the majority of students making attempts at all questions. There was no evidence of students running out of time to complete the paper.

It was evident, in both the pure and mechanics sections, that students can struggle to explain their reasoning. There was often a difference between what a student appeared to mean and what they actually wrote down. Using full sentences rather than abbreviations or shortcuts would help to alleviate this issue. Questions that asked a student to “show that…” usually required a concluding statement and the wording or structure for this could often be found in the question itself. In mechanics in particular, students found great difficulty in identifying relevant modelling assumptions or explaining when or why a model would not apply. Explanations were often too generic, rather than being specific to the context in the question.

Question 1 (Multiple choice)

This question was extremely well-answered with over 90% of students selecting the correct answer.

Question 2 (Multiple choice)

Around 40% of students chose the correct option for this question and this proved to be the most difficult multiple-choice question on the paper. Approximately the same number of students chose the incorrect option of 0, which may have come from the numerator of the expression if a student substituted $h = 0$.

Question 3 (Multiple choice)

Approximately 80% of students chose the correct option, with the most commonly chosen distractor being the quadratic graph.

Question 4

The vast majority, nearly 90%, of students realised the easiest thing to do in this question was to use the sine rule and achieved the first two marks by obtaining the correct acute angle. Only the best students understood the significance of *AB* being the shortest side and realised they were dealing with an example of the ambiguous case of the sine rule.

Some students avoided the sine rule by applying the cosine rule twice. These students, however, often made mistakes solving the resulting quadratic to find side *AB*.

Question 5

Many students were very successful on this question: in each part 80% scored full marks.

In part (a), a common mistake was to include x^2 in the value for B.

In order to achieve full credit in part (b) it is important to note that it is a 'show that' question and this means that the final answer needs to be given in the form requested. It was not acceptable to simply state $C = 320$ and $D = 2000$.

Students who noticed the command 'Hence…' usually scored full marks in part (c), using their answer to part (b) and integrating a very simple expression of the form $Cx + Dx^3$. As this part of the question was testing integration, full credit could be obtained with incorrect values of C and D, or with C and D left unsubstituted.

Students who did not use the previous parts of the question and attempted to reverse the chain rule were often unsuccessful.

Question 6

It was pleasing to see students being reasonably successful on this proof question.

Almost all students made some progress in part (a) with around 65% obtaining both marks. The most common errors came from a lack of attention to detail, such as not explicitly calculating the answer to the sum of their digits.

Part (b) was well-understood and answered correctly by over 90% of students.

While over 80% of students made progress with part (c), only around 40% scored full marks. The two most common mistakes were not checking single digits or missing out 0. For example, some students would square the numbers from 11 through to 20, rather than checking 0 to 9.

Question 7

There were various ways to show the given result. Some students found the area of the whole shaded triangle directly, others found the area of the triangle to the right of the y-axis and doubled this result. Some argued that the required area was the same as that of the rectangle defined by the points *O*, q, Q and the mid-point of *PQ*.

Whichever method was chosen, the first mark was for using $15 - q^2$ as the height, which could have been indicated on the diagram.

Over half of all students made some progress with this part of the question, but many lost marks through not clearly showing how they had formed the given equation. A significant number of students did not find the correct value of c.

While some students did not realise part (b) was about maximising the expression given in part (a), most knew how to start and made good progress, differentiating to obtain $\frac{\mathrm{d}A}{\mathrm{d}q} = 15 - 3q^2$

The phrase 'Fully justify your answer' was understood by many who realised they had to explain that the maximum would occur when $\frac{\mathrm{d}A}{\mathrm{d}q} = 0$ and give some justification that the value they had found was a maximum. Most students opted to check that the value of the second derivative was negative.

A key word in the question was 'exact' and a few students lost a mark for giving a rounded decimal answer.

Question 8

Over 80% of students scored at least one mark for their sketch. A key feature of the required graph is that it does not touch the axes. Many who knew the correct shape drew a sketch which touched one or both axes and did not score full marks.

Nearly 60% of students made some progress with part (b), however a lot of answers did not contain enough detail to achieve full marks. Many students tried to describe what would happen to individual coordinates without explicitly defining the two possible stretches to conclude both Paul and Beth are correct.

Question 9

This question was well-attempted. Over 90% of students were able to make some progress, with over 50% scoring full marks. The first mark was very accessible to anyone who used an algebraic law of logarithms. So, a student who changed $\log_2 x^3$ into $3 \log_2 x$ scored this mark. The second mark was for a correct method to remove logs from the equation, so even if a mistake had been made, this mark could be achieved. For example, if a student incorrectly wrote $\log_2 x^3 - \log_2 y^2 = 9 \Rightarrow \log_2 x^3 y^2 = 9$ and then used a correct step to remove the log term: $\log_2 x^3 y^2 = 9 \Rightarrow x^3 y^2 = 2^9$, they could earn the M1 mark.

Question 10

Nearly 70% of students scored full marks on part (a)(i). Most used the suggested form for the model and identified the correct values for A and B, which would achieve the first mark. Students who had the incorrect values for either A or B could still get the second mark from a clear substitution of $t = 5$ into their model.

As the question is about the number of damaged plants, the final answer needed to be a whole number.

Students who did not use the suggested form of the model and applied repeated percentage change could still achieve full credit, but it took them longer to do so.

In part (a)(ii) students were required to criticise the model. Very few students scored full marks. It is important to remember that comments should be specific to the model in the question and the use of general statements, which could apply to many situations should be avoided. For example, "it grows without limit" could apply to a variety of situations, $x = 1.32t$ for instance. For full credit in this part of the question the solution had to describe the model as growing exponentially and refer to the 900 plants.

For part (b)(i) students had to start with the refined model and show the given result. This question was well-attempted with over half of students achieving full marks. Most students realised they had to obtain partial fractions, but those who lost marks often failed to rearrange the given model appropriately before starting to find the partial fractions.

Part (b)(ii) discriminated well between weaker and stronger students. Nearly 70% of students made some progress and the required techniques seemed well-practised. Many students obtained the first two method marks, but sign errors were often seen. It was common to see answers like $3\ln x + 3\ln(900 - x) = t$, with the arbitrary constant missing, which would score 2 marks. Even with mistakes, the last M1 mark could be obtained for using $t = 0$, $x = 25$, to obtain a value for their arbitrary constant.

Some students who obtained $\int\left(\frac{1}{x}+\frac{1}{900-x}\right)dx=\int\frac{1}{3}dt$, or equivalent, for their answer to (b)(i) could still use this to achieve full credit in (b)(ii).

In (b)(iii) the first mark was for substituting $x = 450$ into their model from part (b)(ii). As it was a method mark it was possible to achieve it by substituting into an incorrect model from (b)(ii). It is important that examiners can tell that this is what is being attempted and students sometimes lost marks through not making this explicit.

Question 11 (Multiple choice)

This question was extremely well-answered with approximately 90% of students selecting the correct answer.

Question 12 (Multiple choice)

Approximately 80% of students selected the correct answer for this question.

Question 13

Full marks were achieved by over 60% of students for part (a) with over 80% making some progress. Most students who attempted this question used the key fact that $v = 0$ in the constant acceleration equation $v^2 = u^2 + 2as$

Students who used a combination of constant acceleration equations could still achieve full credit, but they often made a slip if they used this approach.

The most common mistake seen was an incorrect component of the initial velocity in the vertical direction. As this is a ‘Show that…’ question, students who simply quoted a formula for maximum height were not able to score full credit.

Nearly 70% of students scored full marks in part (b). Those who did not, often decided they had to differentiate to find a maximum or reasoned that the maximum value would be when $\sin\theta = 1$, which put θ outside the stated range of values $0^\circ \leq \theta \leq 60^\circ$

Only around 30% of students were successful in part (c). Many confused size with mass and wrote about the additional force required to get the ball moving in the first place. Some students lost the mark because they did not fully answer the question. For example, an answer like “No. Air resistance.” is not specific enough. While we do not require a lengthy comment, there must be no ambiguity in the student’s answer. There should be a clear statement that Nisha is incorrect **and** air resistance will increase with a larger ball. ‘Drag’ is not a term used in this specification and the phrase ‘resistance forces’ is not specific enough.

Question 14

The mean score on part (a) was just over half marks. It is important that students know that moments require a force multiplied by a distance and, while the correct answer could be achieved through working with mass multiplied by distance, full marks cannot be achieved without using weight rather than mass. Around 15% of students lost a mark because of this.

Other common errors included not accounting for the diameter of the coin, which resulted in an incorrect answer of 12 grams, and taking moments about different points for the coin and the mass, hence forming an inconsistent equation.

Part (b) was correctly answered by approximately 50% of students. Many tried to over explain their assumption often correctly stating that the coin is uniform, which would achieve the mark, and then going on to make an incorrect statement about what uniform means: such a contradiction meant the mark could not be given.

Question 15

This question discriminated well between weaker and stronger students and there were many ways to tackle it with over half of students scoring at least 2 marks. It was pleasing to see most students introduce a variable of their own and form expressions for areas above and below the time axis. Some students used the diagram to do some of their working, which is a sensible approach.

Often mistakes were seen when an equation was formed. Sign errors were introduced when students were unclear whether they were working with area or displacement, both of which were valid methods.

Question 16

This question proved to be very challenging for most students.

There were lots of valid approaches which could be used to answer part (a). As the question did not specify that a vector method had to be used, all valid methods were given credit. Most students who attempted this question realised that particle Q was moving in the direction $\begin{bmatrix} 3 \\ -4 \end{bmatrix}$, but they often made unjustified assumptions about the motion of Q, such as constant acceleration. The simplest solution was to equate the gradients of the direction of motion

eg, $\dfrac{c+1}{9} = -\dfrac{4}{3} \Rightarrow 3c + 3 = -36 \Rightarrow 3c = -39$ hence $c = -13$

Part (b)(i) was the most successful part of question 16, with approximately 50% of students obtaining the right answer. Most realised they had to use the vector equation of $\mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$, but those who were unsuccessful usually forgot to add the initial position of *P*.

Very few students made any progress with part (b)(ii). A common error seen from those who attempted the question, was to equate position vectors for both particles in terms of t. This approach only shows that the particles are not in the same place at the same time and makes invalid assumptions about the motion of *Q*.

The simplest way to answer part (b)(ii) was to find the direction from the position vectors $-4\mathbf{i} + 5\mathbf{j}$ and $\mathbf{i} - \mathbf{j}$ then show that this is not parallel to $\begin{bmatrix} 3 \\ -4 \end{bmatrix}$.

Question 17

This question discriminated well between weaker and stronger students, with nearly 70% able to make some progress and around 25% of students scoring full marks.

While many students knew they had to differentiate the position vector twice to obtain the acceleration vector, applying the product rule in vector form proved challenging for most. Many students found it difficult to organise their work and slips with signs and vector notation were often seen, which meant that by the time an expression for the acceleration was found it was incorrect. Students who found an expression for the acceleration as a vector could achieve the final M1 mark if they went on to find its magnitude.

To achieve full marks students needed to have a fully correct solution with the factor $\sin^2 t + \cos^2 t$ clearly shown, as the final answer was given in the question. As always, it is important not to take shortcuts in a 'Show that…' question.

Question 18

This question was very challenging with only the strongest students making significant progress. The key to part (a) is resolving the tension in the two strings horizontally and equating to zero, since the object is in equilibrium. Many students who attempted this part of the question were able to determine the sizes of the angles required, but often sines and cosines were used incorrectly when resolving.

Of those students who resolved successfully to obtain $T_{OA} = T_{OB}\dfrac{\cos 30}{\cos 48.59}$ and then $T_{OA} = 1.309T_{OB}$, many often forgot to finish with a concluding statement confirming that the tension in the shorter string is more than 30% greater than the tension in the longer string.

The students who had been successful in part (a) were usually able to make good progress in part (b). The first mark was for finding a value for the tension in the longer string. The best students left this in terms of g as they realised it was going to cancel in their equation for the vertical components $mg = 2.6g\sin 48.59 + 2g\sin 30$. The final accuracy mark allowed for some follow through to account for students rounding the multiplier and angles they found in part (a).

Question 19

Having faced two very challenging questions it was pleasing to see a high proportion of students making good progress with the final question on the paper. On average the score for part (a) was over half marks. The first three B1 marks were for obtaining the essential parts of the equation of motion. The omission of g from the components of weight was often a costly mistake, but students could still pick up the first M1 mark for forming the equation of motion. However, some students made sign errors with their forces, which meant they could not obtain the M1 marks.

Part (b)(i) could be attempted even if no progress had been made in part (a) and over 60% of students scored at least 2 marks. Most realised that all that was required was to substitute known values for time and acceleration into the constant acceleration equation $s = ut + \frac{1}{2}at^2$ with $u = 0$.

For students who got this far, the most common error was to forget to subtract the distance found from the length of the ramp.

Part (c) was poorly answered, with less than 20% of students stating an acceptable assumption. It is important to focus on the exact wording of the question. The assumption needed to be about the crate, and it needed to be an assumption the student had made rather than one that is stated in the question. So, assumptions about the rope or the slope were not creditworthy. It is also useful to think about what the previous part of the question was about. Since it was about calculating a distance, it was assumed that the size of the crate could be ignored, which means that it was modelled as a particle.

Mark Ranges and Award of Grades

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