AQA

AS LEVEL
FURTHER MATHEMATICS

7366/2M Mechanics
Report on the Examination

7366
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General

This year students displayed secure understanding throughout the range of topics with some excellent responses seen for each question. There were further improvements in questions relating to dimensional analysis, power with variable resistance and collisions. It was pleasing to see the last question answered well as it combined knowledge of elastic strings and circular motion, the first time this had been tested in this component. The weakest areas were those question parts where students were required to explain or give reasons, along with the topic of impulse. The quality of algebraic manipulation was good throughout and it was pleasing to see clear diagrams being used to aid the development of solutions.

Question 1

This question proved to be a very successful starter with over three-quarters of students choosing the correct answer. The incorrect answer that was most often chosen was 25 J, indicating that students thought they had to make use of the 2 seconds stated and erroneously divided 50 J by 2. Clearly this indicated a confusion between work done and rate of doing work. No option was left unchosen.

Question 2

This question proved to be far less successful than Question 1, with only just over half of students choosing the correct answer. By far the most commonly chosen incorrect answer was $\begin{bmatrix} 8 \\ 2 \end{bmatrix}$ ms^{-1}.
This indicated that students had forgotten to take into account the combined mass of the particles after they had coalesced, hence ending up with twice the correct velocity. No option was left unchosen.

Question 3

Kinetic energy is well understood and almost every student obtained the correct answer for part (a). Rare though it was, an error seen more than once was to forget to square the initial speed.

Most students understood the need to use conservation of energy with potential and kinetic energies in part (b). However, as this question had an answer of 7.3 given, it was necessary to show enough working to score the first two marks. Often students wrote:

$$mgh = 54$$
$$0.75(9.8)h = 54$$
$$\text{Hence } h = 7.3$$

This was only enough to score the first method mark. To score the accuracy mark some rearrangement needed to be shown or a decimal answer with at least three figures needed to be seen.

For the final mark students needed to explain that Gurjas had considered air resistance and that Jeff had not. Many successfully made this comment, although a minority failed to refer to both Jeff and Gurjas in the answer and so did not score the final mark. A handful of students made references to rounding to a number of decimal places which was not relevant to what was being asked.

Question 4

Students' understanding of this topic has improved considerably since the specification started. There were several successful approaches seen for part (a), such as:

- LHS $[w]=L$ RHS $\left[\frac{gt^2}{k}\right]=\frac{LT^{-2}T^2}{[k]}=\frac{L}{[k]}$
- $[k]=\left[\frac{gt^2}{w}\right]=\frac{LT^{-2}T^2}{L}=1$
- $[k]=M^{\alpha}L^{\beta}T^{\gamma}\Rightarrow\left[\frac{gt^2}{k}\right]=\frac{LT^{-2}T^2}{M^{\alpha}L^{\beta}T^{\gamma}}=M^{-\alpha}L^{1-\beta}T^{-\gamma}$
  $\Rightarrow M^{-\alpha}L^{1-\beta}T^{-\gamma}=L\Rightarrow\alpha=0,\beta=0,\gamma=0$

It was pleasing to see more confident use of dimension notation. However, some students lost the final mark by writing $[k]$ = 0, thinking that this meant that k was dimensionless. It was pleasing to see only exceptionally rare occurrences of standard units being used rather than L, M, and T, as such an approach scored zero marks.

Part (b) was very successful with the vast majority of students producing a fully correct solution. When errors did occur, they were either because of incorrect use of laws of indices or an error in the dimensions of gt^2, stating they were LT^{-2} or LT^{-1}.

Question 5

This question was done really well by the vast majority of students. Many clearly stated that at maximum speed the driving force was equal to the resistance or that the acceleration was zero to score the E1 mark. Both $R = Kv$ and $P = Fv$ were used confidently. The most common error was in failing to convert the speed from kilometres per hour to metres per second. A handful of students failed to state units in their answer, which cost them the final mark.

Question 6

Knowledge of impulse has improved considerably since the specification began, but is still an area for further development. Many students knew that for part (a) they had to integrate the force stated and then completed the question successfully. To score the B1 mark, the integral had to be written as $\int_0^T (2t+3)\,dt$, with the mark lost for omission of dt or limits. A few students incorrectly used the formula $I = Ft$ to obtain an impulse of $2t^2 + 3t$, not appreciating the difference between variable and constant forces.

Part (b) was also done successfully. To score full marks here, once a quadratic equation had been formed, students had to clearly rule out any negative T value. It was pleasing to see that students often used their calculator to solve the quadratic accurately. Students who had made errors in part (a) could still score 3 out of 4 marks in this part. Types of errors that were seen in part (b) were:

- sign errors when calculating the impulse that increased the speed from 1 ms^{-1} to 4 ms^{-1}

- calculating changes in kinetic energy and equating this to impulse
- incorrectly solving a quadratic equation, by using algebraic manipulation
- failing to state that time had to be positive and therefore not ruling out any negative solution.

Question 7

The concepts of conservation of momentum and the law of restitution were clearly familiar and there was a further improvement in students' solutions this year. Two answers became evident in part (a), the correct answer 1.2 Ns or the incorrect answer 2 Ns, which arose from not appreciating the different directions of motion involved. A small number of students launched into a full set of equations for this part, even though they were not required until part (b).

In part (b)(i), many students were successful in producing a clear solution that led to the printed answer. Some students carried through the incorrect 2 Ns from part (a) and so could not score the final mark. However, some of those students restarted and produced a fully correct solution for this part, although they did not return to and correct part (a). Unusually, errors were often seen with Newton's Law of Restitution with each of $v - u = e$, $v - u = 4e$, $v - u = -6e$ all being seen. The vast majority of students obtained the correct expression for the speed in part (b)(ii), using one of their correct equations and substituting the answer from part (b)(i).

In part (c) many students clearly stated that $e = 1$ and substituted correctly to show that particle A remained stationary. A small number of students incorrectly used $e = 0$. It was more common to find that students wrote general comments which did not relate to the question that had been asked.

Question 8

It was the first time that elastic strings and circular motion had been tested in a single question. As such the response was particularly good indeed, with the structure of the question helping students to solve the problem successfully.

In part (a) it was essential to refer to Hooke's Law or clearly show how the formula had been used to score the mark. Almost all students did this successfully. Some students quoted the formula $T = kx$ and then just stated $k = 200$, which was not sufficient to score the mark as $k = \frac{\lambda}{l}$ had to be seen.

In part (b) students demonstrated a clear understanding of the formula $T = mr\omega^2$ or $T = \frac{mv^2}{r}$.

Marks were, however, lost by:

- not using a correct expression for the radius, often thinking it was x
- failing to square the value of v
- using weight rather than mass.

Once correctly set up, the algebraic manipulation was good and students obtained the printed answer. Some students were able to recover here as the printed answer helped to identify an earlier error within their working.

Many students were able to successfully solve the printed quadratic and realise that $x = 0.2$, however a final mark was often lost as they then failed to state that the radius of the circle was 1.2 metres. Fewer students used their calculator to solve this equation and preferred to factorise. Students should be encouraged to use a calculator to solve equations in this paper, as marks are weighted heavily to mechanics principles.

Many students were able to state an appropriate limitation in part (d), although some chose to leave this blank. Limitations here should not refer to anything stated in the stem of the question, so referring to the smooth table or perfect circle were not limitations of the model used by students. The most common limitations related to the string having no mass or no air resistance being considered.

Mark Ranges and Award of Grades

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