CM Question Reports

M1 - Practice Paper A

This report

When writing my papers, I author questions for particular purposes and to help tease out key ideas and skills. This report will examine the reasoning behind the different questions of this paper and, based on the cohort of students that sat this paper, the strengths and weaknesses that were brought out.

This particular paper was sat by 67 students and the distribution of marks, along with my estimated perception of the relative difficulty of the paper[1], gave rise the following grade boundaries:

Grade	A	B	C	D	E	U
Mark	63	56	49	42	36	< 36

Question 1

This question proved to be a highly accessible opening to the paper, with just under 80% of the candidates scoring full marks. The majority of candidates were able to identify which of the 'SUVAT' equations to use here and the most frequent error arose when students took both the initial velocity of the particle and g to be positive. It is suggested that students should consider the nature of their answers, because students who made this mistake only obtained one positive value for t - which lacks reason because the particle must come down if it has been projected upwards. However, it was pleasing to see that the majority of students gave their answers to two or three significant figures.

[1] The *relative difficulty* is a comparison of the observed difficulty of this paper and existing M1 papers, an inspection of the distribution of the marks achieved in those papers and the grade boundaries that were consequently set.

Question 2

This proved to be a discriminator among candidates and caused some students great difficulty. Part (a) was usually completed correctly, with students often using a correct method to find the velocity vector for S and then going on to show the given result adequately. The word 'adequately' is one that candidates should bear in mind; huge leaps of faith and benefits of doubt that are often ascribed when an answer is not given are not in a 'show that' question. Candidates should show all their workings and frivolous attempts to 'fool' the examiner by smudging their workings to *appear* they have obtained the given answer will just not work. In part (b), strong candidates adeptly set the $\mathbf{i}$ component of $\mathbf{r}$ equal to zero, although many others set $\mathbf{j}$ equal to zero and didn't seem to understand the concept here. In part (c), responses were, once again, varied. Most appreciated that Pythagoras would need to be applied at some point, but simply substituted $t = 30$ into $\mathbf{r}$, failing to acknowledge that this is the position vector of $\mathbf{r}$ and not its displacement. The mean mark for this question was 6.8/11.

Question 3

This question was very well answered by the majority of candidates, proving to be relatively straightforward. Moments equations were almost always correct where they were seen, although errors and inconsistencies in the direction of these moments were common sources of error. Moments were taken about a variety of points, and as long as these points were clearly defined, then credit was given where progress was made. Most candidates chose to use one moments equation and then resolve to find the second quantity in question, although completely correct solutions involving two moments equation were also seen. After Question 1, this was the second highest scoring question in the paper.

Question 4

Like Question 1 and 3, this question was answered well by candidates, with a success rate of just over 73%. In part (a), candidates often used N2L horizontally and formed a correct equation which was also then solved correctly. It was seen that some candidates tried to resolve vertically and then switched to resolving horizontally when they realised this was not going to be successful for this part of the question. An issue with this was that candidates then simply wrote the answer for part (b) or gave minimal working (because they had done it in part (a)). This was problematic when they had made an arithmetic slip because credit cannot be given for one part if it is labelled under another part. Also, in part (b), some candidates achieved masses of the order of 10^6 grams - it was surprising that candidates were convinced by such values given the tension in AB was so small. Some candidates thought that the tension in AB was equal to the tension in AC, which was a shame.

Question 5

Candidates who drew a diagram in this question were much more successful, on average, then candidates who didn't. The majority of candidates were able to resolve parallel and perpendicular to the plane and obtain an equation in α. The large issue came when candidates where unable to solve this equation. C1 and C2 knowledge is expected and this includes use of trigonometric identities, and so it was a shame to see that this was the most common loss of marks for candidates. Confusion over sin and cos when resolving was also an error for many students and omitting the component of the weight when resolving parallel to the plane was another frequent error - one that a diagram would help to overcome. Drawing a diagram is the largest, most single piece of advice that should come out of an analysis of the responses to this question.

Question 6

This question discriminated well between weaker candidates, but not very well between stronger candidates. Apt, mute responses to this question were often seen by strong candidates, who drew diagrams and carefully applied the conservation of linear momentum and paid heed to the directions (and consequent signs) involved. In part (b), some candidates took the direction of C to be the CBA, which was strange considering it was hit in the direction ABC - if a stationary particle is hit in the direction ABC, it is hard to see why it would travel in the direction CBA. Part (c) was only answered correctly by candidates who paid close attention to the directions of the particles after their respective collisions. Basic arithmetic errors were seen throughout the question and a careless omission of m in one of the terms when applying the conservation of linear momentum led other candidates into troubles.

Question 7

On the whole, parts (a) and (b) of this question was well answered by the majority of candidates, although weaker candidates were less successful in part (c). 75% of candidates were able to gain full marks in (a), by considering the two particles individually and solving the resulting simultaneous equations. Errors arose from inconsistent directions with the two equations, i.e. the acceleration of A being in the opposite direction to its tension, or basic arithmetic slips when solving the simultaneous equations. In part (b), almost all candidates who had found a tension in part (a) scored full credit here, by realising that the resultant force on the pulley was twice the tension in each of the strings. There were, on the other hand, some peculiar attempts at Pythagoras seen. Part (c) proved to be one the hardest questions on the paper for some candidates. While full marks were regularly seen, some candidates left this blank or did not make much progress on this unstructured question. Another source of error came about when candidates worked out the height A reaches above the point when the string loses tension, but did not then proceed to work out the highest point it reaches above the ground. Candidates should read the question carefully and, perhaps, in such cases, draw a diagram to remind themselves of what they are being asked to calculate.

Question 8

This question had a varied success rate, with some candidates scoring fruitfully while others making very little progress indeed. In part (a), the majority considered the entire system which allowed them to work out the acceleration of the system. They usually then went on to score full marks in part (b) and (c) too, using a similar method. Other candidates were stumped when they tried to consider the caravan and trailer separately, leading them to an equation with two unknowns that they seemed to give up on. Parts (d) and (e) had a very low success rate with just under 39% of candidates scoring full marks on both. While in part (d), most candidates appreciated the need to use a 'SUVAT' equation here, many did not seem to appreciate the need to find the deceleration of the system. It was disappointing when candidates did not seem to know how to do this, considering they had already applied the correct method in part (a). In part (e), strong candidates considered either the caravan or the trailer and used the direction of the force in the rod as an indicator of whether the rod was in tension or thrust. However, other candidates were able to calculate the force in the rod but showed little awareness of the distinction between tension and thrust. The final three marks were only obtained by the strongest candidates who had achieved full marks in the previous parts. Candidates who had errors in their previous parts that would impede on their graph were entitled to only 1 of the 3 marks.

Overall Comments

This mechanics paper seemed to provide candidates with a suitable assessment of their abilities. The more straightforward questions at the beginning of the paper allowed for less able candidates to showcase their knowledge, while the rigour embedded in some of the other questions allowed for discrimination and stretch and challenge among higher scoring candidates. A few tips for candidates to bear in mind for the future would be:

- Where unstructured questions are set, a diagram is often helpful in allowing students to devise a logical method to find the correct answer.
- In a question where g is required, it should be taken to be 9.8 and answers then given to two (or three) significant figures. Not doing so is self-penalising.
- Candidates should check the suitability of their answers to ensure they are judicious, such as in Questions 1 and 4.
- Reading the question carefully will save some students marks, such as in Question 7, where far too many good candidates did not calculate the height A reached above the ground.
- Where answers are given, candidates should show all the stages of their workings. They should be reminded that examiners will be able to spot when candidates are attempting to deceive.
- Candidates need to begin to appreciate the physics behind their workings, rather than simply memorise methods as this will tend to be fruitless when new question styles arise.

Statistically, this paper had a mean mark of 54 and there were a few eloquent scripts within the relatively small cohort that scored full marks.

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