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Examiners' Report
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International Advanced Level in Mechanics M2

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General Comments

This paper was very accessible with many learners achieving success throughout. This was clearly reflected by the fact that full marks proved to be the modal mark on all seven of the questions. The paper had a very positive start with almost 70% of candidates scoring full marks on question 1, questions 3 and 6 were also very well received. The last question presented a tougher challenge, as did question 4, while the level of success on the remaining questions was very similar. There were some excellent scripts but there was also a substantial number where the standard of presentation could be improved, particularly with respect to clarity and the size of writing. This, in some cases, made it very difficult for examiners to follow the working and award marks accordingly.

In calculations the numerical value of g which should be used is 9.8 m s^{-2}, as stated on the front of the question paper. Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised, including fractions but exact multiples of g are usually accepted.

N.B. If there is a given or printed answer to show, e.g. as in 4(a) and 5(b), then learners need to ensure that they show sufficient detail in their working to warrant being awarded all of the marks available.

In all cases, as stated on the front of the question paper, learners should show sufficient working to make their methods clear to the examiner and correct answers without workings may not score all, or indeed, any of the marks available.

If a learner runs out of space in which to give their answer, then they are advised to use a supplementary sheet – if a supplementary sheet is not used, then it is crucial for the candidate to say whereabouts in the script the extra working is going to be done.

Question 1

Most learners were able to use the power and velocity to obtain the correct driving force. Many of those also went on to answer (a) and (b) completely correctly. Common errors seen were to ignore the resistive forces and simply equate the driving force to $650a$ or to include the tension or an incorrect mass. In part (b), some of those who had little success in (a) were able to pick up 2 marks for a correct equation in their T. Most used the equation of motion for the trailer in (b), again often correctly – the most typical errors were problems with signs.

Question 2

Part (a)

This was generally very well done. Some tried to form an expression for the impulse using speeds rather than velocities, but most worked correctly.

Part (b)

In (b), most learners formed a correct ratio for a relevant angle, but a considerable number gave an answer of 68.2° rather than the correct 111.8°. A significant number obtained no marks in (b) because they worked with the final velocity rather than the impulse.

Question 3

Part (a)

Part (a) was done correct by most learners, as was the integration in part (b).

Part (b)

Finding the value of the constants in (b) sometimes led to arithmetic errors, but a great many successful solutions were seen. An occasional issue was omitting **i** or **j** from the final expression for **r**.

Part (c)

In part (c), more correct equations in T were seen than perhaps on similar questions in previous series. Some learners formed simultaneous equations in a constant, but most proceeded directly to ratios. Some slips in rearranging led to some learners having the wrong quadratic, but most found $T = 6$ correctly. Some stopped here, thinking their work was done, or found the velocity and stopped, but most went on to find the speed. In both (b) and (c) exact values were required, and some learners lost marks for failing to heed this.

Question 4

Part (a)

This question marked a step up in challenge in the paper. Whilst a good number of fully correct solutions were seen, it was clear that some learners struggled to set up the equation for the centre of mass in (a). Common errors included not halving the areas of the circles to get semi-circle areas, making sign errors in the equation or other arithmetic slips. Occasionally those that had a correct equation lost the final mark due to sloppy algebra, missing a's or not referring to d in the final given equation.

Part (b)

Part (b) was very well done, including by those who had not made progress in (a). Some learners worked through to find the vertical distance of the centre of mass from B rather just using the symmetry of the figure.

Part (c)

Part (c) was also well done, although several learners found the centre of mass of the new system rather than setting up a moments equation from the beginning. Sign errors or incorrect distances in the equation were often seen. Those taking moments of points other than B often scored no marks as they did not include the horizontal force at B.

Question 5

The given answers in parts (a) and (b) allowed many learners to succeed in (c) regardless of earlier success. In both (a) and (b), the given answers were sometimes reached via incorrect working that contained slips.

Part (a) and Part (b)

In (a), for example, equations might have a's appearing and disappearing inconsistently or in (b), the a's might not have appeared in the moments equation at all. Overall there was a good number of fully correct solutions.

Part (c)

Part (c) was very well done, with candidates using the result from (b) correctly for the most part. Horizontal and vertical resolutions were the most common, and most likely to be successful, although some candidates did work correctly with

moments about B, C or the centre of the rod. Common errors seen were incorrect values for the trig ratios or sign errors in the vertical resolution equation.

Question 6

This question was very well done compared to similar, recent questions.

Part (a)

Sign errors were often seen in part (a), typically in the impact law, but the given result meant that learners could still access all the marks in (b), if they had a correct CLM equation, and also in part (c).

Part (b)

In part (b), learners who used the value of e to find v_P and v_Q before calculating the kinetic energy made their working much simpler and less prone to errors than those who worked through in terms of e, before finally substituting $e = {}^{2}/_{3}$. Forgetting to square the 4 in $4u$, and other slips were seen at times, as well as subtracting the KE of P after the collision, but adding the KE of Q.

Part (c)

In part (c), there were many correct solutions and a good number who had the right idea but made a sign error in their equation leading to a value of ${}^{12}/_{5}$. There were also learners who appeared to be working with the particle P instead of Q, or were using the mass $3m$ instead of m.

Question 7

Part (a)

Part (a) was often done very well, although an answer of ${}^{98}/_{13}$ was seen on occasion or answers were given to 4 sf or more.

Part (b)

Part (b) was also well done, with many equations including all terms – but sometimes with sign errors. There were learners who omitted terms, and it seemed equally likely to omit the initial KE, the GPE or the WD.

Part (c) and Part (d)

Parts (c) and (d) were independent of the answer to (b). However, some learners incorrectly used the initial value they had found in (b) instead of 26 for the projection speed. There were also learners who did not resolve the 26 to find the vertical component. Most learners did form correct equations in both (c) and (d), using a variety of approaches listed in the mark scheme. Again, there were sign errors and premature approximation often led to a final answer for (d) of 57.9 instead of the correct 57.8. The addition of 5cos(alpha) was usually included correctly, but a considerable number of responses omitted this.