AQA

# A-LEVEL

# Mathematics

## MM1B – Mechanics 1B
## Report on the Examination

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## General Comments

Students found several of the questions very accessible while other questions posed a greater degree of challenge. One area that caused issues for some students was related to their use of vectors; there were a number of instances where students used inappropriate methods when working with vectors. One particular issue that emerged in this paper was students' inability to equate components of vectors when required; a significant number of students did not do this well. Some students produced incorrect equations by, for example, equating the sum of the components rather than considering individual components.

## Question 1

There were many very good responses to this question, particularly for parts (a) and (b). The main errors that were seen here were generally arithmetic or as a result of quoting a constant acceleration equation incorrectly or making substitution errors when applying it.

There were more errors in part (c). These fell into two categories. Firstly, there were those who produced a three term equation of motion with the correct terms but the wrong signs. The second common error was to simply calculate the magnitude of the resultant force using the product of the mass and the acceleration.

## Question 2

This question was done very well by students and there were many correct solutions. A small number of students did not seem to be able to start and a few made errors when using trigonometric ratios to find the angle in part (b), but these were generally of a minor nature.

## Question 3

This question contained a lot of accessible material and many students gained a good number of marks, although very few were awarded full marks. In part (a), many students found the acceleration correctly, but some did it in two stages finding the time first. This approach seemed to increase the number of minor errors made by the students.

The force diagrams were generally drawn well in parts (b) and (c), but when considering the van, some students included a friction force as well as a tension force. In part (c), the question about the advantages of modelling the van as a particle was not answered well, with very few students noting that there would otherwise be a need to consider four normal reaction forces. There were many inappropriate or incomplete comments such as 'the vertical forces will balance'.

Finding the friction force, in part (d), was generally done well, with relatively few errors.

There were many good solutions to parts (d), (e) and (f) about the motion of the connected bodies. However in the last part there were more errors than in the earlier parts. There were several reasons for this: one was the introduction of the weight but more common were cases where an inappropriate combination of forces or masses was used. For example some students when considering the van included both the friction and the tension, others used an incorrect mass. Some students considered the whole system but used either the mass of the skip or the van, but not the combined mass of both.

## Question 4

This question proved to be quite challenging. Part (a) was found to be difficult by many students. There were two common incorrect approaches. The most simplistic of these was to divide the width of the river by the speed of the boat and obtain a time of 10 seconds. The second was to find the length of the path of the boat and divide this by the time of 2, which produced and answer of 10.1 seconds.

Part (b), was generally done well and very few students had a problem with this. A few students used trigonometric ratios incorrectly, for example writing $\sin\theta = \frac{3}{20}$ and using the result to find $\alpha$.

Part (c) was also quite demanding and students used a variety of approaches. Those who drew a correct velocity triangle were very often successful, as they were able to use this to efficiently find $V$. Those who used the sine rule were more successful than those who used the cosine rule. The issue with the cosine rule was that many students did not know the magnitude of the resultant velocity and instead used a distance, for example 20.2, rather than the correct velocity.
The most common incorrect approaches to this question were generally based on the consideration of right-angled triangles, rather than the correct scalene velocity triangle.

## Question 5

This question was either done very well or very badly by students. The first issue was that a number of students did not use the correct value for the total mass after the collision. A common error was to use $2mk$ rather than $m + km$. A number of students were able to produce a correct equation for the conservation of momentum, but not able to manipulate this by extracting and equating components to form scalar equations. A lot of inappropriate vector manipulation was seen on the scripts. One problematic answer that this led to was $k = 1.5\mathbf{i} + 1.5\mathbf{j}$.

## Question 6

This question also posed a good deal of challenge to some students, while others were able to deal with the demands very efficiently. A good number of students were able to obtain the correct velocity in part (a). One of the most popular incorrect approaches was to use the equation $s = \frac{1}{2}(u+v)t$ with $u = 0$.

In part (b), some students used their answer to (a) and completed the question without difficulty. However, there were a number of students who tried to find a new time of flight rather than using the value of 1.8 given in the question. This was often done on the assumption that the flight started and ended at the same height. This of course led to an incorrect distance. A few students obtained a value of -1.21, but did not then say that the distance between $A$ and $C$ was 1.21 metres.
Part (c) was done very well and many students gained the mark.

## Question 7

Part (a) was often done well with many students obtaining the correct velocity.

Part (b) was found to be very much more demanding and only a small number of students gained full marks on this question. There were many incorrect approaches. The most basic of these was to continue with the time of 10 from part (a). Another incorrect approach was to work with expressions for the velocities rather than the positions.

A number of students made an appropriate start by producing expressions for the position vectors at time $t$, although quite a lot of these students omitted the initial position. Moving on from these position vectors created problems. A common error was to add the components together to create a single but incorrect quadratic equation, rather than equating the components from each position vector to obtain two quadratic equations. Other students only used one equation and when they obtained $t = 14$, simply calculated the position vector from this but did not verify that both $A$ and $B$ would have this position vector at the same time.

## Question 8

There were many quite good answers to part (a) of this question. Most successful students obtained values for $F$ and $R$, and then used these to get the correct coefficient of friction. A few students used the result $\mu = \tan 30°$. There were a small number of students who omitted $g$ from their working, but obtained the correct final answer.

Part (b) was more demanding and there were many confused responses to this question. Common errors were the use of incorrect signs or solutions based on incorrect resolving of the forces. In some cases no attempt was made to resolve either both or one of the required forces.

Part (c) was found to be very difficult, with very few correct responses. The main source of difficulty was with setting up a correct equation of motion. The most common error was to omit one term from the equation, often the component of the weight. A typical incorrect start was to work with an equation like $X\cos 30° - F = 40 \times 0.2$. Other students did include all of the terms, but made sign or resolving errors. Those who did make some progress were able to substitute for the friction. There were many minor arithmetic or algebraic errors which resulted in incorrect final answers.

## Mark Ranges and Award of Grades

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

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**UMS conversion calculator** www.aqa.org.uk/umsconversion