Pearson
Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2024

Pearson Edexcel International Advanced Level
In Mechanics M1 (WME01)
Paper 01

WME01 June 2024 Examiners' Report

General

The vast majority of candidates were able to make attempts at all eight of the questions and the paper had a reasonably friendly start with the modal mark on both of the first two questions being full marks. There were a few incomplete attempts at question 8 but it wasn't clear whether this was a case of candidates running out of time or running out of ideas. There were some excellent scripts. However, there were also a substantial number where the standard of presentation left a lot to be desired. This, in some cases, made it very difficult for examiners to follow the working and award marks accordingly.

Questions 5 and 6 were the best answered followed closely by question 1. The question which caused the most problems was question 3 and to a lesser extent question 7, and in both cases, a substantial number of candidates were unable to make any progress.

In calculations the numerical value of g which should be used is 9.8 m s^{-2}. 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, as in 7(b) for example, then candidates need to ensure that they show sufficient detail in their working to warrant being awarded all of the marks available and in the case of a printed answer, that they end up with *exactly* what is printed on the question paper.**

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

If a candidate runs out of space in which to give his/her answer than he/she is advised to use a supplementary sheet – if a centre is reluctant to supply extra paper then it is crucial for the candidate to say whereabouts in the script the extra working is going to be done.

Question 1

In part (a), there were a good number of fully correct solutions but this wasn't always recognised as a straightforward conservation of momentum problem and quite a few failed to set up the correct equation as a starting point. There were sign errors as well as incorrect equations with some failing to include the zero and others having the zero linked to the wrong mass. Quite a few responses had both particles starting from rest or particle *B* moving prior to the string becoming taut and a significant minority of candidates left the speed as negative. The question asked for *S* in terms of *U*, and although it was permitted to use a different letter to *S* in the working, candidates lost a mark if they did not use *S* in their answer.

In the second part, most candidates showed a good knowledge of the impulse-momentum equation but again there were sign errors and using the wrong mass in an impulse equation was occasionally seen. Surprisingly, the majority of responses used particle *A* to find the impulse, rather than using particle *B* which was much easier since it started at rest. The final mark was often lost because it had been left as negative and some lost the *U* and presented a dimensionally incorrect expression for the impulse. A number of candidates did not attempt the question.

Question 2

Those candidates who resolved in two perpendicular directions and then used Pythagoras tended to have more success than those who attempted to use the cosine rule on a triangle of forces. A common error with this approach was to use an incorrect angle of 30, 60 or in some cases 330 degrees, even when they had drawn what appeared to be the correct obtuse angled triangle. Occasionally an incorrect formula was used for the cosine rule. Some weaker candidates just applied Pythagoras to the two forces of 8 and 10.

Question 3

Almost all candidates attempted this question but many seemed unfamiliar with this type of situation involving two tensions. This question either produced a very neat and concise solution or lots of crossings out and multiple doomed attempts. If candidates achieved no marks it was generally for including an extra 3mg term in their system equation of motion or for missing the 3mg term when giving the equation for Q. Drawing a separate diagram for each of P and Q would have helped some candidates to set up these equations correctly.

Many succinct solutions used the equation of motion for P to find a = g/4 and then used this within an equation of motion for Q or for P and Q combined to get to the required answer. Others were successful in solving their equations simultaneously. Sign errors in the equations were quite rare but some candidates lost marks due to the omission of or extra inclusion of g. Some omitted ‘m’ from their mass term or simply used ‘ma’. Some responses showed confusion between the T value given and the T value to be found, resulting in the substitution of T = 3mg into the wrong place, or adding it in as an additional force. A few candidates assumed that both tensions were equal.

Question 4

In questions of this type, candidates should be encouraged to say about which point they are taking moments as this helps examiners to understand the approach being used. In part (a), many realised that the *smallest* value of M would mean that the rod was about to tilt about C and therefore took moments about C. This produced an equation with M as the only unknown and quickly led to the answer as the g's cancelled. Those that took moments about a different point required two equations to solve the problem and this inevitably led to more errors being made. Many correct responses were seen for part (a) but usual errors involving incorrect signs or lengths or inconsistent inclusion of g, led to wrong answers, whatever method was used.

In part (b), it was surprising to see how many candidates chose to use two equations to solve the problem, obtaining the mass of the particle as 4 kg before going on to find the normal reaction required. Some of those who found the mass of the particle first thought they had answered the question and stopped. As in the first part, careful consideration of the information given would have shown that only one moments equation about the 'tilting point' E was needed. Errors included incorrect lengths or, in some cases, losing the final mark due to overspecification of a decimal answer if not given as a multiple of g.

Question 5

In part (a), the vast majority of candidates used an appropriate *suvat* method to find the distance fallen by the box in the first 5 seconds after leaving the helicopter. However, many failed to round their answer to 2 or 3 significant figures as required following the use of g = 9.8 ms-2 and so lost an accuracy mark.

The second part required consideration of the motion once the parachute had opened. Most candidates appreciated that a new acceleration needed to be found using F = ma with the new given resistance. This was generally done well although occasionally the weight term was omitted from the equation of motion. There were a substantial number of correct answers seen for the speed at which the box reached the ground. The most common errors included assuming the initial velocity of the box was zero, taking the displacement as the total height of the helicopter above the ground and, the most common, assuming that the box was accelerating rather than decelerating. Those who carried forward a rounded value from part (a) sometimes lost accuracy in their final answer here. A very small number of candidates failed to realise there were two distinct stages of the motion and used an acceleration of 9.8 ms-2 throughout.

The total time of flight was required in part (c). Since the initial and final velocities, deceleration and displacement were all known, there were a variety of *suvat* approaches that could be used to find the time for the second stage of the motion. The time for the first stage of the motion was given as 5 seconds and most then added this to find the total time as required. Those who were carrying forward incorrect values from previous working could still achieve two out of the three available marks. Occasionally, despite entirely correct working in part (b), candidates reverted to using an acceleration of 9.8 ms-2 for the total distance in order to find the total time.

The speed-time graph sketch in the final part was completed with mixed success. Most realised that two straight lines were required. Those who used an acceleration rather than deceleration in the second stage of the motion had both sections with positive gradients which constituted an incorrect shape. The second mark required relevant annotations on the axes but follow through values from previous working were acceptable. Some who used entirely correct methods throughout the question failed to achieve marks here through having the graph meet the t-axis at t = 20, thereby assuming zero velocity at the instant immediately before the box hit the ground.

Question 6

In part (a), most candidates made a correct start by resolving vertically and horizontally, finding the friction force, using F=1/3R, then showing enough working to usually reach a dimensionally correct equation for T in terms of mg. Confusion between sines and cosines, sign errors and poor algebraic manipulation prevented many candidates from accruing accuracy marks. Less proficient candidates failed to consider the vertical component of the tension, assumed that the normal reaction was mg and lost method marks as a result.

In the second part, a substantial number did not recognise that the system was subject to a different acceleration and were unable to make any progress. Those that did tended to score most of the marks. Some candidates included an extra term when calculating the friction force and occasionally the final A mark was lost due to the omission of d or an error in the algebraic manipulation. Solutions using the work-energy principle were seen but rarely correct.

Question 7

Part (a) was well done on the whole but a significant number showed a lack of knowledge of bearings and an answer of 12**i** +16**j** was often seen. There were also longwinded methods involving the use of Pythagoras and some candidates wrote 12**j**+16**i** which wasn't helpful, especially as others had **i**'s and **j**'s that were difficult to distinguish. Pleasingly, very few answers were left in the form of a column vector.

The vast majority of candidates got the second part right although there a few who tried to use the 20**j** and 40**i**.

In part (c), most candidates spotted the need to subtract (40t**i** + 20**j**) from their answer to part (b) and some now realised they were incorrect in parts (a) and (b) and used this as an opportunity to correct one or both of their previous answers. In general, candidates were good at giving the **exact printed answer**, as required, but a few still lost marks through careless labelling or through not writing it in the required form, including $\overrightarrow{AB}$ =.

In part (d), equating the **i** and **j** components of **AB** to zero and showing that this led to different values of *t* was usually the most successful approach, but a significant number of candidates wrote down an incorrect time of 24/10 rather than 10/24 and some did not draw a conclusion from their two (correct) times. Many found an expression for *AB* but did not know what to do next. Of those that did equate it to zero, many lost the final mark for failing to mention ‘no real roots’. Those using the derivative method often confused the *t* value, when the minimum occurs ($^7/_{12}$), with the minimum value of d^2 (80). Some attempts at part (d) assumed that the **i** and **j** components of **AB** were equal and effectively attempted part (e) instead.

Part (e) was poorly attempted, with a number of responses trying to square both components of $\overrightarrow{AB}$, which resulted in the same equation that was created in part (d). For those who attempted part (e), nearly all understood the need to find a value for *t* and use this along with Pythagoras’ theorem to find the distance. Many set up numerous incorrect equations in an attempt to find *t*.

Question 8

The majority of candidates were able to derive the given expression for the frictional force in part (a). Since the answer was given, it was important for correct and complete working to be shown. The few who used a decimal value rather an exact fraction for cosα were penalised.

The equation of motion for the particle moving vertically was generally stated correctly in part (b) although a few candidates were unsure about what was required and attempted some type of *suvat* equation.

In part (c), many candidates attempted an equation of motion for the particle moving up the plane, often reasonably successfully although errors seen included sign errors and a missing weight component. Some, despite stating a correct equation in (c), substituted ‘3*mg*’ for *T* in their equation. Those with correct equations of motion tended to solve them correctly to find the given acceleration. Those with incorrect equations often started to solve, realised that they wouldn’t reach the given answer so just optimistically wrote down a =1/3g. Since they had not actually completed a solution they lost a method mark as well as the final accuracy mark.

Part (d) proved challenging for many candidates who either omitted it or made little valid progress. It is possible that time constraints had a limited part to play as a few responses seemed to stop midway through a correct process but these cases were rare and lack of understanding appeared to be the more prevalent issue. Some failed to realise the need for a new acceleration after one particle has hit the ground and some just assumed $a = g$ throughout. A few found an expression for the speed when the string goes slack but then used it again for the first part of the motion to find that the distance was indeed *h* which, of course, they had already assumed. Those who attempted to use a new equation of motion for the particle moving up the plane often did so successfully although errors such as omitting the weight component or having a sign error were not uncommon. The new acceleration was generally used in a suitable *suvat* method to find the distance, and then most remembered to add a further *h* to give the total distance travelled, as required.