Examiners' Report
Principal Examiner Feedback

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

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General

The paper seemed to work well with the majority of candidates able to make attempts at all eight of the questions. The paper had a friendly start with the modal mark on both of the first two questions being full marks and there was no evidence of time being an issue. There were some excellent scripts but there were also some where the standard of presentation left a lot to be desired. This, in some cases, made it difficult for examiners to follow the working and award marks accordingly.

Rather surprisingly Question 1 turned out to be the third worst answered question of the eight, although 1, 5, 6 and 8 all performed in a very similar way. The best answered question by some margin was number 3 with question 2 a very close second. Question 4 proved, by a long way, to be the most challenging.

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.

If there is a given or printed answer to show, as in 3(a) and 5(a), 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), most candidates resolved horizontally to give $T\cos\theta = 2$ which then led to the correct answer. Almost all then resolved vertically in the second part but a significant number omitted one of the forces and lost all 3 marks. Of those that had a correct equation, a number left their final answer as 0.4 or $4/g$ or 20/49 and lost the final mark. Some candidates continue to throw away marks by using $g = 9.81$ or even 10 but it was pleasing to note that confusion between sin and cos, when resolving, is becoming rarer. Other common errors included an omission of g, e.g. $T + T\sin\theta = M$, or trying to use different tensions in the two parts of the string. A few candidates did not appreciate the static nature of the scenario and introduced an acceleration e.g. $T\cos\theta - 2 = Ma$ or $T + T\sin\theta - Mg = Ma$ and made little progress.

Question 2

Part (a) was generally well answered but some poor algebra led to some incorrect solutions. It was not uncommon to see incorrect solutions to a correct quadratic or for x multiplied by x to turn into $2x$ or for x's to just cancel. Most candidates were able to set up a quadratic equation in x using the conservation of linear momentum but a number had a sign error on 1.5. Most candidates did reject the $x = -4$ solution when seen but often did this by putting brackets around it which may not always be clear to an examiner. A significant minority thought that one of their x values was the unknown mass and the other was the unknown velocity, so chose $x = 2.5$ for mass and $x = -4$ for velocity. A small proportion of candidates opted to set up an equation in x by comparing impulses. These candidates were generally less successful. Most candidates made a good start to the second part and gained the method mark by using the impulse-momentum principle on A to set up an equation. The vast majority of candidates also scored the first A mark by correctly attempting a difference of momenta, although it was not unusual for candidates to lose the second A mark by failing to give the magnitude of the impulse, leaving a negative answer. Those candidates who used B to set up their equation were ill advised to do so as this used their answer for x which was often wrong and meant that they could only score the M mark.

Question 3

In part (a) most candidates were able to derive the given result, usually by using $s = \frac{1}{2}(u+v)t$. However, a significant minority did so using rather labour-intensive approaches which used multiple equations and either elimination or finding the acceleration before the final answer. A small number of candidates used or quoted incorrect formulae including $s = \frac{1}{2}(u-v)t$ and tried to spuriously argue why their u value should be taken as a magnitude. For part (b) most candidates scored marks for finding the acceleration, which was often done in another part. The majority of candidates successfully completed this part using a quadratic in t, but a common error was to use $s = 200$ with $u = 12$ and $v = 28$ or to assume half the time or half the speed corresponded with half the distance. The final part was the worst answered with a significant number of candidates calculating a final answer of $1200(0.8) - 260 = 700$, usually without writing a complete equation of motion.

Question 4

Many candidates found this a challenging question and many made no progress. Common incorrect approaches included assuming equilibrium (for example, setting $X\cos 30° = 5\sqrt{3}$) or joining the end-points of the forces **P** and **Q** and trying to use an incorrect triangle with 150° opposite the "resultant". A number of candidates misunderstood vector addition and tried to add their components and equate the sum to $\sqrt{129}$. The most successful candidates either used components or drew an appropriate vector triangle and used the cosine rule. Many of the same candidates then successfully applied the sine rule but of those who then went on to find the appropriate obtuse angle the majority were those who had also sketched a correct diagram. A significant number of candidates achieved only 2 marks for calculating angles of 52° or 38°. A significant minority of candidates who were otherwise correct did not give the final answer to the nearest degree as required.

Question 5

In part (a), the most common method was to take moments about *D* to find the given expression for the reaction at *C*. There were occasional errors in distances or when expanding brackets but, nevertheless, many did achieve the three available marks. Those who chose to take moments about another point and eliminate the reaction at *D* (usually by using a vertical resolution equation) gave themselves more work and greater opportunity for error. A variety of approaches was seen in part (b). The most straightforward was to use vertical resolution and the answer from (a) to write down an equation in the unknown distance *x*. The reaction at *C* was stated as being four times the reaction at *D*; however, a fairly common mistake was to actually use the relationship the other way round in the equation. Those who took moments about another point often found the reaction at *D* in terms of *x* and then equated this to $\frac{1}{4}R_C$ successfully. In the final part, it was given that the rod was on the point of tilting about *C* so those candidates who failed to realise that the reaction at *D* would be zero could achieve no credit. A more common error was to include a term corresponding to the 55 kg mass despite the question specifying that this was removed before the new *M* kg mass was added. A few candidates used the expression for the reaction at *C* given in (a) which showed a lack of understanding of the situation. Nevertheless, there were a fair number of entirely correct solutions seen.

Question 6

In part (a), the most successful candidates generally used either one *suvat* equation for the whole motion or used two steps e.g. finding the height to the top, adding 2.5 m to this and then using it to find *V*. There were many variations and complete solutions using other combinations of *suva*t equations did appear. Some candidates used the symmetry of the motion and occasionally the conservation of energy principle was applied. The most common errors involved signs but other errors involved using incorrect *suvat* formulae or confusing speeds at different parts of motion e.g. using a speed of 24 m s^{-1} at the top of the motion or assuming that the speed at *A* was zero. In part (b), there were correct solutions involving one, two or even three steps but the first M mark did require a *complete* method. The multiple step methods involved splitting the motion into up and down and again the most common mistakes tended to be sign errors. In the third part, the most efficient method was to solve $10 = 24t - \frac{1}{2}gt^2$ and find the difference in the roots. Others found the time to the 10 m mark and found the difference between this and the time to the top and then doubled the result. Others considered the velocity at the 10 m mark and then worked out the time to achieve this from *A* or the top. Occasionally energy equations were formed and solved. Common errors included using incorrect signs and thinking that the height was 10 m from *B* or 10 m below the top position. In the final part, all that was required was a symmetrical V shape, with the second part being longer than the first, together with the labels of 24, their *V* value and their answer to part (b). Candidates should appreciate the difference between a speed-time graph and a velocity time graph and care was also needed to show the symmetry between the two straight lines.

Question 7

In part (a), virtually all candidates knew that speed was the magnitude of velocity and used Pythagoras on the given vector successfully. Again, in the second part, most could write down the required position vector at time *t* using the given initial position vector and velocity. The question specified that the answer was to be given in terms of **i**, **j**, and *t* so those who only gave a column vector were penalised; however, such instances were rare. Solving the problem of closest approach to the lighthouse in part (c) proved significantly more challenging. Some candidates gave up almost straight away whilst others had no valid strategy. A common error was in using Pythagoras on the position vector of *S* (ship) or *L* (lighthouse) rather than on the vector **SL** (or **LS**) as required. Some used methods seen in past papers, such as equating components of the position vectors or writing them as ratios but these approaches were not relevant here. Those who formed the vector **SL** generally proceeded to find the magnitude, although there were occasional sign errors and arithmetic slips when simplifying to obtain a three term quadratic. Most used differentiation or completing the square to deduce the value of *t* that minimised the expression although calculator methods were acceptable. Some equated their quadratic to 1.3^2 and made no further progress. There were alternative methods such as using gradients and the equations of lines or a relevant scalar product which, although rarely seen, tended to be completed successfully. When determining the safety of the course some candidates compared d^2 rather than d to 1.3. A small number incorrectly concluded it was unsafe despite having correctly found the closest distance to be 1.4 km.

Question 8

In part (a), most candidates were able to gain the first two marks by resolving perpendicular to the inclined plane to find an expression for the normal reaction. This usually led to candidates also gaining the second B mark for using $F_{max} = \mu R$. Most candidate were also able to set up an equilibrium equation for particle P, gaining the second method mark and usually the following accuracy mark. Less proficient candidates, however, failed to appreciate that the system was in limiting *equilibrium* and introduced a spurious '*ma*' term leading to loss of both method and accuracy marks although some saved themselves by finally stating $a = 0$. Despite having been able to set up a correct equilibrium equation a minority of candidates were unsuccessful in reaching the correct value for μ due to sign errors, sin/cos confusion and/or poor algebraic manipulation. Although generally well attempted, there were relatively few completely correct solutions to part (b). A common error was to have the friction acting in the wrong direction. The use of g as the acceleration was rarely seen and generally the correct forces appeared in the equation of motion. A common incorrect final answer was 2.06 which usually came from premature approximating a to be 2.64 m s^{-2}. Answers to more than 3sf were rarely seen.

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