Examiners' Report
Principal Examiner Feedback

January 2023

Pearson Edexcel International Advanced Level
In Mechanics M2 (WME02) Paper 01

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

January 2023
Publications Code WME02_01_ER_2301

General

Many of the scripts for this paper contained clear responses of a high standard. The majority of the candidates offered responses to all eight questions, although there were instances of blank responses in all questions.

In the best scripts the work was logically presented, and each step was explained. Those candidates who used annotated diagrams in their responses often achieved a clearer understanding of what was happening.

The rubric to the paper gives candidates clear instruction about the value to use if they substitute for *g*, and the appropriate accuracy for final answers. Candidates who do not follow the rubric will lose accuracy marks. Although this has been highlighted in previous reports, it continues to be a common reason for the loss of marks.

For this paper, there were several errors due to confusion between sine and cosine, most notably in question 6 and question 7. There were also several instances of candidates resolving terms that did not need to be resolved and omitting the resolution of terms that should have been resolved.

Some candidates do not use brackets correctly: there were several examples of brackets that should not have been there, for example when change in kinetic energy was quoted as $\frac{1}{2}m(v-u)^2$. Similarly there were several errors in multiplying out brackets and in the use of "invisible brackets" (when a candidate does not put in the brackets and then forgets that they should have been there).

Report on Individual Questions

Question 1

(a) Most candidates scored full marks here. The most common error in equations that attempted to use the correct terms was to use 30 in place of 30000.

(b) The equation of motion for the truck moving up the inclined road was more challenging but there were several fully correct solutions. The most common error was to treat $0.2\ \text{ms}^{-2}$ as an acceleration. The other common errors were sign errors and omitting a term from the equation.

Question 2

Most candidates formed a correct equation for the impulse and momentum. A small minority of candidates subtracted the terms in the wrong order. Many candidates compared the coefficients of **i** and **j** at this stage to obtain $x=1$ and $y=2\lambda+3$ before going on to consider the change on kinetic energy. Those candidates who formed a correct equation for the change in kinetic energy usually obtained the correct answer. Several candidates misunderstood the question and thought that the kinetic energy of *P* after receiving the impulse was 22 J. A minority of candidates attempted to use $\frac{1}{2}m|\mathbf{v}-\mathbf{u}|^2=22,$ and some candidates did not use the squares of the speeds in their calculation of kinetic energy. Those candidates who reached a correct equation in *y* often overlooked one of the two possible solutions.

Question 3

(a) The majority of candidates obtained the given answer from clear and correct working. The most concise solutions used a rectangle with a triangle removed, but there were other ways of dividing the lamina that proved successful. There were several instances of candidates identifying an error in their working and correcting it. In these cases, it is much easier for the examiner to confirm that the revised working is correct if the candidate writes out the solution again rather than attempt to write over the original solution. The most common errors were due to an incorrect assumption about the position of the centre of mass of the triangle or the inconsistent use of a in the equation.

(b) There were many fully correct solutions. There was evidence of confusion about which angle was required: some candidates obtained an answer of 47, but then concluded that $\theta = 43$. The question requests that the answer is given as a whole number of degrees, so 47.0 is not correct and an answer in radians is not correct.

Question 4

This question was a good source of marks for many candidates. However, a significant number of candidates scored no marks because they attempted to answer the question by using the *suvat* equations.

(a) The majority of candidates associated the direction of motion with the velocity and obtained the given answer correctly. There were a few slips in the algebra and in the arithmetic.

(b) There were some slips in the differentiation and in the arithmetic, but the structure of the majority of solutions was correct. A small number of candidates found **a** but did not go on to find **F**. Some candidates gave a correct answer for **F** but did not go on to find the magnitude.

(c) There were some slips in the integration, but the majority of candidates went on to use the initial position correctly. A minority of candidates made inappropriate attempts to use the *suvat* equations.

Question 5

(a) The two key steps required here were to obtain the force due to friction and to use this to find the work done. Several candidates used sine rather than cosine when resolving perpendicular to the ramp. Some candidates did not use the coefficient of friction at all. The question asks for the work done against friction, so those candidates who only stated the total work done against the weight and the friction scored a maximum of 1 mark.

(b) The question asks for the use of the work-energy principle, so alternative methods scored no marks. There were many fully correct solutions. A small number of candidates gave their final answer to inappropriate accuracy after using $g = 9.8\,\text{m s}^{-2}$. The most common errors were sign errors in the energy equation, double counting of the change in GPE and omitting a term from the equation.

(c) Here again, the use of the work-energy principle was required. Candidates who made a sign error in their equation for part (b) often made a matching error here. A few candidates used the equation for the journey from A to A, but the majority considered the journey from B to A.

Question 6

(a) The majority of candidates attempted to use moments about *A*. Several candidates claimed to have obtained the given answer from an incorrect equation. Most errors occurred in trying to deal with the thrust in the light rod, and there were several instances of confusion between sine and cosine.

(b) The most common approach was to resolve horizontally and vertically. The small minority of candidates who attempted to resolve parallel and perpendicular to the pole often made errors in dealing with the force(s) acting at *A*. A small number of candidates attempted a second moments equation, but this usually involved errors in dealing with the force(s) acting at *A*. The candidates who resolved correctly usually obtained the correct answer.

Question 7

(a) There were many fully correct solutions. Any errors were usually due to not taking sufficient care when reading the question to extract the information about the directions of motion of *P* and *Q* before and after the collision. Most candidates followed the structure of the question and did not attempt to use the impact law in part (a).

(b) Most candidates understood what they needed to do, and many gave the correct answer. The algebra was much simpler if they considered the impulse received by *P*, but the candidates needed to note that the question asked for the magnitude of the impulse.

(c) The majority of candidates started with a correct statement of the impact law. This allowed them to find an expression for *e* in terms of *k*. They then needed to form two inequalities using $0 < e \leqslant 1$. Most candidates stated one correct inequality, but few understood the significance of the information that $v \neq u$.

Question 8

(a) This is a standard piece of bookwork, and those candidates familiar with the equations for the horizontal and vertical motion of a projectile often scored the majority of the marks. There were some sign errors in the equation for the vertical motion, and some candidates did not explain the final step in the working to obtain the given answer: candidates are expected to know that $\sec^2\alpha = 1 + \tan^2\alpha$ but the relationship $\dfrac{1}{\cos^2\alpha} = 1 + \tan^2\alpha$ is not one of the commonly quoted results and should be explained.

(b) This part of the question says that it is about mechanical energy, so it does not use part (a). Those candidates who followed the instruction often obtained the correct answer. A few of the final answers were over-specified following the use of g = 9.8 m s^{-2}. Several candidates made incorrect attempts to use *U* and 25 in a *suvat* equation.

(c) The most efficient way to answer this part of the question is to use the result from part (a). It is possible to work through from first principles, but the candidates who tried to do that rarely got as far as an equation in $\tan\theta$. The most common error in applying the equation from part (a) was a sign error in the vertical distance.

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom