Examiners' Report

Principal Examiner Feedback

January2020

Pearson Edexcel International GCE

In Mechanics Mathematics 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

Grade Boundaries

Grade boundaries for all papers can be found on the website at:
https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

January 2020
Publications Code WME02_01_2001_ER

General

Much of the work presented by the candidates was of a high standard, but some candidates did find aspects of this paper challenging.

The most successful candidates set their work out clearly, with labelled diagrams, descriptions of what their equations represented, and detailed working.

When checking their solutions candidates should pay close attention to the algebra and arithmetic. It is common for candidates to start with correct equations but reach an incorrect final answer. This was particularly prevalent in question 8 on this paper.

Candidates should read the questions carefully to avoid misreading information and to ensure that they find what they have been asked to find. A minority of candidates are not clear about the difference between vectors and scalars.

The rubric for this paper states clearly that candidates should be using $g = 9.8$ and the appropriate accuracy to use in final answers, but several candidates lose marks through not following these instructions. Candidates should aim to write clearly: not only do the examiners find some of the handwriting difficult to read, but candidates often misread their own writing.

Report on Individual Questions

Question 1

This proved to be a very accessible question for the majority of candidates, with many scoring full marks. The most common error was to assume that the cyclist was moving up the road rather than down, resulting in a sign error in the equation of motion.

The solution of this question involves substituting a value for *g*, so a final answer expressed as an exact fraction is not appropriate.

Question 2

The majority of candidates understood how to find the magnitude of the force due to the friction between the package and the ramp, but far fewer went on to find the work done against the friction as the package moved up the ramp. Most candidates used correct expressions for the loss in kinetic energy and the gain in gravitational potential energy, but many of the work-energy equations involved the friction, not the work done against friction, making them dimensionally incorrect. There is still a significant minority of candidates who include both the gain in potential energy and the work done against the weight.

The question asked candidates to "use the work-energy principle", so solutions using the *suvat* equations were not accepted.

Question 3

Many candidates who used the vectors and applied the impulse - momentum principle correctly reached fully correct answers.

The most common error was to treat the initial velocity and the impulse as if they were acting in the same direction. Several candidates did this to find the speed of P immediately after receiving the impulse, but then went on to consider the components to find the required angle. Several candidates used the scalar product to find the angle between the two vectors.

Some candidates attempted to use the cosine rule and the sine rule in a triangle of vectors. This was usually done with reference to an incorrect triangle formed by simply adding a third line to the diagram given in the question.

Question 4

(a) The majority of candidates understood the basic process for using moments to find the position of the centre of mass of the lamina. Some made the working longer than necessary by considering two stages, one to find the position for the rectangle with the semicircle removed, and then a second step to add on the semicircle. Some candidates used an incorrect expression for the area of the semicircle, and some did not have the area of the lamina equal to $18a^2$. Candidates should take care to ensure that their equations are dimensionally correct - there were several instances of a's disappearing and then reappearing in the final (given) answer.

In this question the candidates were given the formula for the position of the centre of mass of a semicircular lamina. Some candidates preferred to work with the formula for a sector (as given in the formula book) - this was successful provided they used the correct angle. There were several errors due to candidates using $\frac{4r}{3}\pi$ rather than $\frac{4r}{3\pi}$.

Some candidates used the given answer as a guide to find and correct errors in their working. Several candidates claimed to have reached the given answer from incorrect working.

(b) The majority of candidates who attempted this part of the question started with a correct method to find the position of the centre of mass of the loaded template. Most went on to use the value of $\tan\phi$ to form an equation in k, but fully correct solutions were rare.

Question 5

This question was a good source of marks for many candidates.

(a) The majority of candidates understood the correct process to use. Many went on to state the magnitude of the acceleration. Provided they had clearly stated the acceleration in a correct vector form they scored full marks. A small number of candidates obtained a correct expression for the acceleration in terms of t but then made an error in substituting $t = 0$.

(b) Most candidates worked with the velocity of P. Some candidates equated the direction to $(\mathbf{i}+11\mathbf{j})$ and some equated $\mathbf{v}$ to $(11\mathbf{i}+\mathbf{j})$. Those candidates working with an incorrect quadratic equation usually scored no further marks because they did not show any method for solving their equation and it was rare for an incorrect quadratic equation to have two positive roots.

There were several fully correct solutions, but some candidates found the required velocity and did not go on to find the corresponding speed.

(c) Most candidates found a correct expression for the position vector of P, and the majority went on to consider when $\mathbf{r} = \mathbf{0}$. There were some very clear explanations of the given result, but some candidates reached a point where they could have drawn the correct conclusion and did not take that final step.

Question 6

(a) Many candidates obtained the given answer through correct working. The simplest way to achieve this was to resolve vertically and to take moments about A. Some candidates followed a more complicated route, e.g. resolving parallel to the rod and taking moments about C.

(b) The majority of candidates started by resolving horizontally to obtain an expression for the friction acting at A.

Most candidates knew that there was a relationship between F and μR, but very few used $F \le \mu R$. The majority of candidates worked through with an equation for μ and then appeared to guess which inequality to use. Some candidates believed that μ had a maximum value of 1.

Some accuracy errors were caused by incorrect arithmetic in substituting values for the trig. ratios.

Question 7

(a) Most candidates used the correct method and obtained the correct answer. In the course of the working, a value is substituted for g, so answers given to more than 3 significant figures were not accepted. A few candidates used $\frac{1}{2}m(v-u)^2$ for the change in kinetic energy.

(b) There are several possible approaches to this question, but the simplest considers the vertical distance moved by P. There were a few sign errors in setting up the equations, but many correct solutions.

(c) Most candidates adopted the simplest approach here and equated the two expressions for the horizontal component of the speed. The final answer was often stated as $31.7°$ resulting from premature approximation in the course of the working.

(d) A similar question has been asked several times in recent past papers, and the majority of candidates gave a correct solution.

(e) The *suvat* equations offer a variety of possible ways to tackle this task, and many candidates completed it correctly. Some candidates found a relevant value of t but did not go on to find the value of T. Those candidates who used the equation for vertical distance to find the two values of t at the ends of the interval often did not go on to find the difference between them. The method mark here was only available for a complete method to find T.

Question 8

The majority of candidates started by attempting to form equations for the impact and the loss in kinetic energy. A large number of candidates did not use the information given about the directions of motion of the particles after the collision - some even had the two particles passing through each other. The signs used in the equation for conservation of momentum and the equation for the impact law were usually consistent. Most candidates understood how to form an expression for the change in kinetic energy, but there were several sign errors in the final equation.

Having set out the initial equations, several candidates did not go on to attempt to solve for any of the unknown values. Many candidates did form an equation in one unknown, but they often stopped at that point, and showed no attempt to solve their equation. There were several errors in the algebra and arithmetic, some in the course of squaring a bracket, and some when trying to simplify expressions.

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