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Oxford Cambridge and RSA

AS/A LEVEL GCE

Examiners' report

MATHEMATICS

3890-3892, 7890-7892

4729/01 Summer 2018 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects that caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper 4729/01 series overview

Candidates once again showed that they were well prepared for the demands of this module, with only a small minority appearing to be lacking in the mechanical ability required.

Examiners saw a wide variety of scripts, both in terms of presentation and achievement. The paper enabled all those prepared for it to show what they could do, but also provided a good level of challenge for more able candidates.

The level of algebraic manipulation required was again high, but the majority were able to cope with this demand. Some however did seem to labour over this when there were more efficient ways to achieve required results, such as with 7(i) in particular.

Question 1

1 A car of mass 1300 kg is travelling uphill along a straight road inclined at 6° to the horizontal. The resistance to the motion of the car is constant and equal to 350 N. The car's engine is working at a rate of 24.5 kW. Find the acceleration of the car at an instant when its speed is $12\,\text{m}\,\text{s}^{-1}$. **[3]**

The majority of candidates answered this question well. Candidates must remember to use a dimensionally correct Newton's 2nd Law equation, including the requirement for the acceleration due to gravity in the weight term.

Question 2 (i)

2 A particle P is projected with speed $35\,\text{m}\,\text{s}^{-1}$ at an angle of 41° above the horizontal. Calculate

(i) the maximum height of P above the level of the point of projection, **[2]**

This proved a good source of marks for the majority of candidates. The majority either used standard constant acceleration equations, or quoted and used standard results for maximum height achieved by a projectile. A common error was for candidates to quote a correct formula, but then use it incorrectly.

Question 2 (ii)

(ii) the speed and direction of motion of P at time 3 s after projection. **[5]**

The vast majority of candidates were able to pick up 4 of the 5 marks in this question. A few candidates did not include the 'below' required for the direction. Candidates are best served by having a suitably labelled diagram with direction arrows if they have any doubt that their statement about direction is ambiguous.

Question 3 (i)

3 A small ball of mass 3 kg is held at a height of 20 m above a horizontal floor. The ball is projected vertically downwards with a speed of $4\,\text{m}\,\text{s}^{-1}$. The only forces acting on the ball are its weight and a resistance to motion of magnitude 3.525 N.

(i) Use an energy method to find the speed of the ball immediately before its impact with the floor. **[5]**

This part proved tricky for a significant number of candidates. The main errors were in omitting at least one energy term from a conservation of energy equation and also having incorrect signs with the terms. As in previous years, some candidates duplicated the gravitational potential energy term by also including the work done by the weight.

Question 3 (ii)

The coefficient of restitution between the ball and the floor is 0.6 and after the ball hits the floor it rebounds vertically upwards.

(ii) Find the magnitude and direction of the impulse exerted on the ball by the floor. **[3]**

The request for the magnitude of impulse is usually well done and this proved to be true again. As in previous years however, candidates often miss the request for the direction of the impulse; a statement rather than a diagram is the best way of describing this

Question 3 (iii)

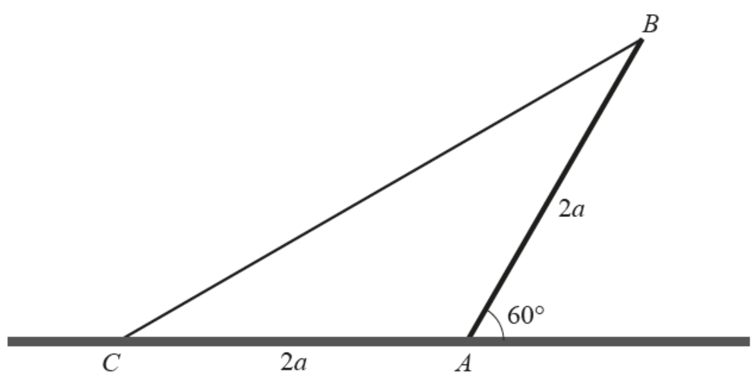
While travelling upwards the resistance to the motion of the ball remains at 3.525 N and the ball first comes to instantaneous rest at a height h m above the floor.

(iii) Find h. **[3]**

Two possible approaches were seen, although those who continued to use an energy method where more successful. The constant acceleration approach required an acceleration that is not equal to g, because of the resistance present (a fact missed by a significant number of candidates using this approach).

Question 4

4

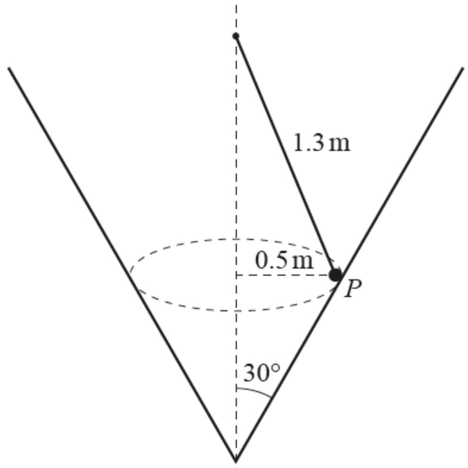


A uniform rod AB, of length $2a$ and weight W, rests in equilibrium with the end A in contact with rough horizontal ground. The end B is connected to a point C on the ground by a light inextensible string so that A, B and C lie in a vertical plane. The rod is inclined at an angle of 60° to the horizontal and $AC = 2a$ (see diagram). The system is in limiting equilibrium. Find the tension in the string in terms of W, and calculate the value of the coefficient of friction between the rod and the ground. **[8]**

As with all requests on this aspect of the specification, candidates are best served by taking moments once and resolving twice. They can take moments more than this, but experience has shown that candidates are more prone to errors in taking moments rather than resolving. Candidates performed significantly well however. Common errors were in geometry to find the angles in the triangle ABC. A minority omitted giving the tension in the string in terms of W as requested.

Question 5 (i)

5



A conical shell, of semi-vertical angle 30°, is fixed with its axis vertical and its vertex downwards. A particle P, of mass 0.2 kg, is in contact with the smooth inner surface of the shell. One end of a light inextensible string of length 1.3 m is attached to P and the other end is attached to a fixed point on the axis of the shell. P moves in a horizontal circle of radius 0.5 m (see diagram).

(i) Given that the angular speed of P is $5.2\,\text{rad s}^{-1}$, find the tension in the string. **[6]**

Candidates generally knew what to do here and were able to set up the correct equations to gain the first 4 marks. The equations then had to be solved, but algebraic errors were not uncommon. Unfortunately a number of candidates still believe that a normal reaction is equal to weight no matter what the situation. The best advice for a circular motion with constant speed questions is to resolve horizontally and vertically.

Question 5 (ii)

(ii) Find the least possible speed of P for which P remains in contact with the shell. **[3]**

This part is a different situation from that in (i) and as such a new value of tension is required. The approach was to have the normal reaction as 0, however a significant minority thought that the tension in the string was 0. Candidates should ensure that they answer what is being requested, as some were unfortunately finding angular speed rather than speed.

Question 6 (i)

6 Two small spheres A and B, of masses $2m$ and $4m$ respectively, are free to move in a straight line on a smooth horizontal table. Initially B is stationary and A is moving with velocity u directly towards B. Sphere A collides directly with B and the coefficient of restitution for the collision between A and B is e.

(i) Show that the velocity of B after the collision is $\frac{1}{3}u(1+e)$ and find a similar expression for the velocity of A after the collision. **[5]**

The majority of candidates answered this question well. A small point to note is that expressions should be simplified to gain full credit.

Question 6 (ii)

It is given that 24% of the kinetic energy of the system is lost in the collision.

(ii) Find the value of e. **[3]**

This was well answered by candidates who dealt with the 24% kinetic energy loss appropriately. This is effectively using 0.76 x (Initial KE) = Final KE.

Question 6 (iii)

A third small sphere C of mass $5m$ is free to move in the same straight line as A and B. After the collision between A and B, sphere B subsequently collides with C. The coefficient of restitution between B and C is 0.9, and before this collision C is stationary.

(iii) Show that there are no further collisions. **[5]**

This part proved tricky for a significant number of candidates, some of whom only considered further collisions between spheres *B* and *C*. Candidates needed to be in a position to be able to compare the speeds of *A* and *B* after the second collision, hence there was a need to substitute the coefficient of restitution found in (ii). In cases where this was done successfully, candidates should then have compared speeds rather than velocities.

Question 7 (i)

7

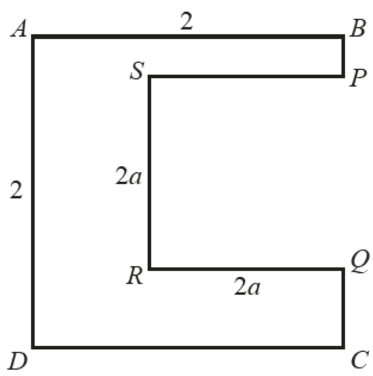


Fig. 1

Fig. 1 shows the cross-section through the centre of mass of a uniform solid prism. The cross-section is a square $ABCD$ of side 2 with a square $PQRS$ of side $2a$ removed. It is given that the centre of mass of the prism lies on the line through R and S.

(i) Show that $2a = \sqrt{k} - 1$, stating the value of the constant k. **[8]**

Candidates usually do well on the centre of mass question and this was the case again here. Most were able to set up a moments equation using an appropriate axis, leading to a cubic equation in *a*. Solving the cubic was difficult for some, while others either resorted to their calculator to solve, or realised that *a* – 1 was a factor using their knowledge of the factor theorem.

Question 7 (ii)

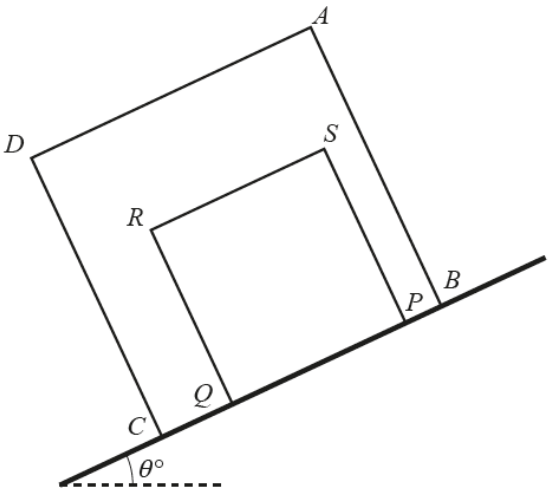


Fig. 2

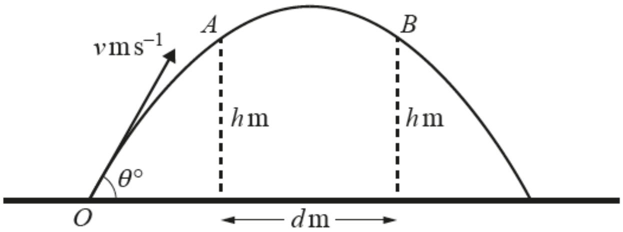
The prism is now placed on an inclined plane which makes an angle $\theta°$ with the horizontal. BC lies along a line of greatest slope with B higher than C (see Fig. 2). The plane is slowly tilted until the prism topples, without slipping, when $\theta = 30$.

(ii) Find the distance of the centre of mass of the prism from CD. **[3]**

As a consequence of some not having a full solution to part (i), candidates assumed that this part was inaccessible with a significant number not attempting this at all. Candidates should be advised that marks can still be credited for the correct method to solve the problem and in this case 2 of the 3 marks could still be credited even without a value of *k* from (i).

Question 8 (i)

8



A particle is projected with speed $v\,\mathrm{m\,s^{-1}}$ from a point O on horizontal ground. The angle of projection is $\theta°$ above the horizontal. The particle passes, in succession, through two points A and B at a height h m above the ground and at a distance d m apart (see diagram).

(i) By considering the horizontal and vertical components of the velocity of the particle at A and B, show that

$$4v^4\sin^2\theta\cos^2\theta - 8ghv^2\cos^2\theta - g^2d^2 = 0.$$ **[7]**

This proved to be the most difficult question on this paper. All methods were treated equally in an attempt to get to the given answer. The most successful approach was to use an equation of trajectory, derived or quoted, and setting *y* = *h*, which gives a quadratic equation in *x*. Solving this equation then results in 2 values of *x*, then the difference between these values being *d*. Typically candidates scored the first 3 marks, but then the algebraic manipulation proved difficult for a significant number of candidates.

Question 8 (ii)

(ii) Given that $\theta = 60$, $h = 30$ and $d = 22.5$, find the value of v. **[3]**

By contrast, this should have been a relatively straightforward request. Candidates were expected to substitute the given values into the expression given in part (i), which produces a quartic equation in v, but is a hidden quadratic in v^2. Calculators can solve quadratic equations, but candidates need to be sure that the use this facility correctly if marks are to be credited.

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