

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

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Pearson Edexcel Level 3 GCE

Wednesday 14 June 2023

Afternoon (Time: 1 hour 30 minutes)

Paper
reference

9FM0/3C

Further Mathematics

Advanced

PAPER 3C: Further Mechanics 1

You must have:

Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear.
Answers without working may not gain full credit.
- Unless otherwise indicated, whenever a value of g is required, take $g = 9.8 \text{ m s}^{-2}$ and give your answer to either 2 significant figures or 3 significant figures.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 7 questions in this question paper. The total mark for this paper is 75.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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5.

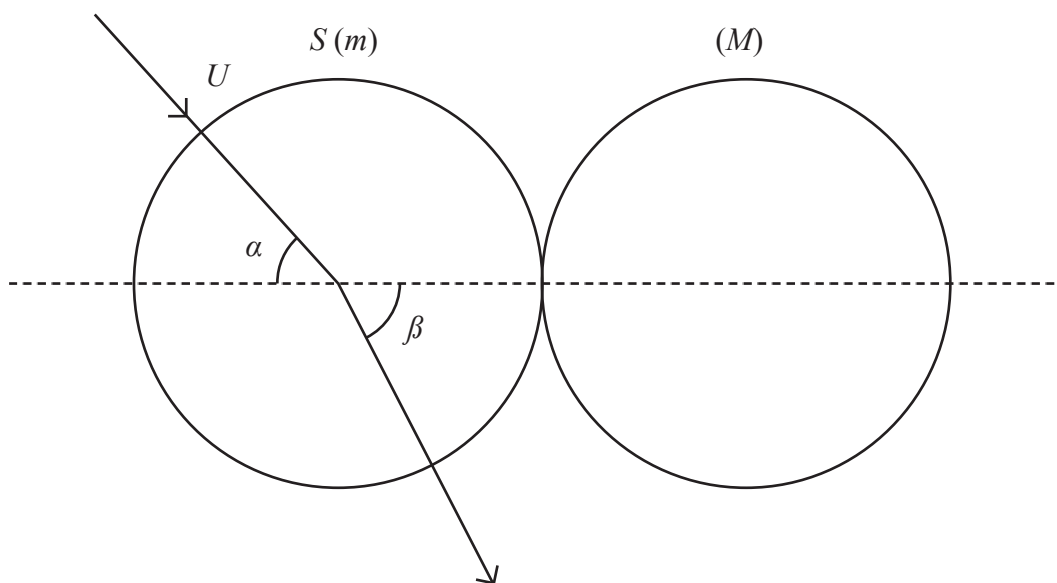


Figure 1

A smooth uniform sphere S of mass m is moving with speed U on a smooth horizontal plane. The sphere S collides obliquely with another uniform sphere of mass M which is at rest on the plane. The two spheres have the same radius.

Immediately before the collision the direction of motion of S makes an angle α , where $0 < \alpha < 90^\circ$, with the line joining the centres of the spheres.

Immediately after the collision the direction of motion of S makes an angle β with the line joining the centres of the spheres, as shown in Figure 1.

The coefficient of restitution between the spheres is e .

(a) Show that $\tan \beta = \frac{(m + M) \tan \alpha}{(m - eM)}$ (8)

Given that $m = eM$,

(b) show that the directions of motion of the two spheres immediately after the collision are perpendicular. (2)



7.

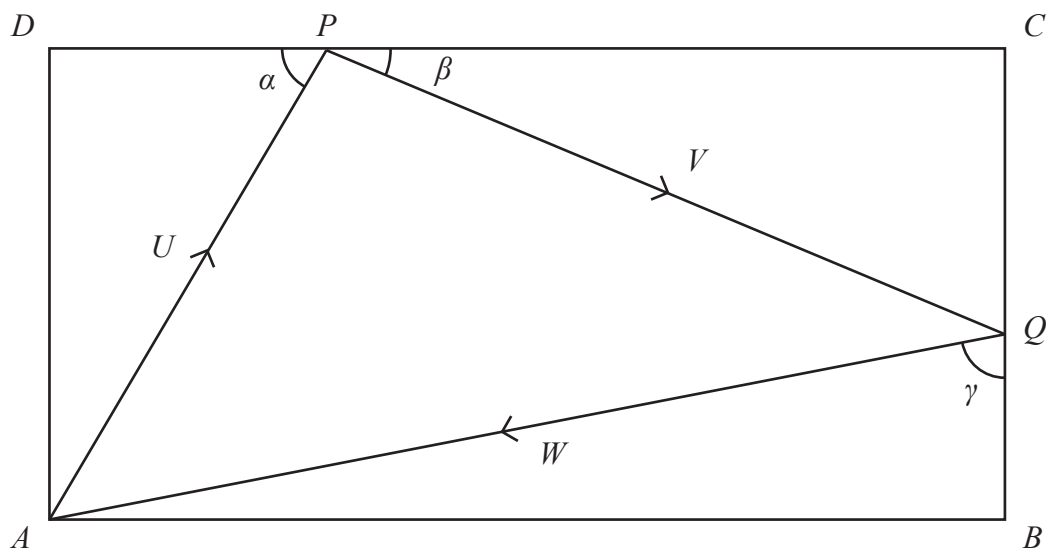


Figure 2

A small smooth snooker ball is projected from the corner A of a horizontal rectangular snooker table $ABCD$.

The ball is projected so it first hits the side DC at the point P , then hits the side CB at the point Q and then returns to A .

Angle $APD = \alpha$, Angle $QPC = \beta$, Angle $AQB = \gamma$

The ball moves along AP with speed U , along PQ with speed V and along QA with speed W , as shown in Figure 2.

The coefficient of restitution between the ball and side DC is e_1

The coefficient of restitution between the ball and side CB is e_2

The ball is modelled as a particle.

Use the model to answer all parts of this question.

(a) Show that $\tan \beta = e_1 \tan \alpha$ (4)

(b) Hence show that $e_1 \tan \alpha = e_2 \cot \gamma$ (3)

(c) By considering (angle $APQ +$ angle AQP) or otherwise, show that it would be possible for the ball to return to A only if $e_2 > e_1$ (6)

If instead $e_1 = e_2$, the ball would **not** return to A .

Given that $e_1 = e_2$

(d) use the result from part (b) to describe the path of the ball after it hits CB at Q , explaining your answer. (1)



