Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Mock Paper Set 1

(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 algebraic 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 numerical value of g is required, take $g = 9.8\,\text{m}\,\text{s}^{-2}$ 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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Answer ALL questions. Write your answers in the spaces provided.

1. A lorry of mass 2500 kg pulls a trailer of mass 500 kg along a straight horizontal road. The trailer is attached to the lorry by a tow bar that is horizontal and parallel to the direction of motion. The resistance to the motion of the lorry is 300 N and the resistance to the motion of the trailer is 120 N. The tow bar is modelled as a light rod.

At the instant when the speed of the lorry is $20\,\text{m s}^{-1}$, the lorry is accelerating, the tension in the tow bar is 200 N and the power being developed by the engine of the lorry is P kW.

(a) Find the value of P.

(6)

(b) Explain how you have used the modelling assumption that the tow bar is inextensible in your solution to part (a).

(1)

Question 1 continued

(Total for Question 1 is 7 marks)

2. Two smooth uniform spheres P and Q, of equal radius, are both moving with speed u on a smooth horizontal plane. The spheres are moving in opposite directions along the same straight line when they collide directly. Sphere P has mass $2m$ and sphere Q has mass $3m$. The coefficient of restitution between the spheres is e.

Prove that if $e > \frac{1}{4}$ then the direction of motion of Q is reversed by the collision.

(8)

Question 2 continued

(Total for Question 2 is 8 marks)

3. A small ball has mass 0.6 kg. The ball is projected vertically upwards with speed $22.4\,\text{m}\,\text{s}^{-1}$ from a point that is 1.5 m above horizontal ground. The ball is modelled as a particle and air resistance is ignored. The ground is soft and the ball sinks 2.5 cm into the ground before coming to rest. The resistive force exerted by the ground on the ball is modelled as a constant force of magnitude F newtons.

Find, using **only** the work-energy principle, the value of F.

(4)

Question 3 continued

(Total for Question 3 is 4 marks)

4. Particle A, of mass m, is moving with speed u on a smooth horizontal plane towards an identical particle B, which is at rest on the plane. Particle A collides directly with particle B. The coefficient of restitution between the particles is e.

Given that 42% of the total initial kinetic energy of the two particles is lost in the collision,

(a) find the value of e.

(10)

If instead $e = 0$,

(b) describe, as fully as possible, the motion of the particles after the collision.

(2)

Question 4 continued

Question 4 continued

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Question 4 continued

(Total for Question 4 is 12 marks)

5. A small ball of mass 0.5 kg is moving on a smooth horizontal plane with velocity $(4\mathbf{i} - \mathbf{j})\,\text{m s}^{-1}$ when it strikes a fixed vertical wall. Immediately after the impact the velocity of the ball is $(2\mathbf{i} + 3\mathbf{j})\,\text{m s}^{-1}$. The ball is modelled as a particle and the wall is modelled as a smooth plane surface.

(a) Find the magnitude of the impulse of the wall on the ball in the impact.

(4)

(b) Find the loss in kinetic energy of the ball due to its impact with the wall.

(3)

(c) Find the coefficient of restitution between the ball and the wall.

(5)

(d) Verify that the component of the momentum of the ball, parallel to the line of intersection of the wall and the horizontal plane, is unchanged by the impact.

(2)

(e) State which modelling assumption ensures that the component of the momentum of the ball, parallel to the line of intersection of the wall and the horizontal plane, is unchanged by the impact.

(1)

Question 5 continued

Question 5 continued

Question 5 continued

(Total for Question 5 is 15 marks)

6. A light elastic spring, of natural length l and modulus of elasticity mg, has one end attached to a fixed point A on a rough horizontal table. The other end of the spring is attached to a particle P of mass m. The particle P is held on the table at a distance $2l$ from A. The coefficient of friction between P and the table is $\frac{1}{4}$

The particle is released from rest.

(a) Find the distance travelled by P before it first comes to rest.

(6)

(b) Explain why, when P first comes to rest, it is only at rest for an instant.

(3)

(c) Find where P comes to rest for the second time.

(5)

(d) Describe what happens to P next, explaining your answer.

(2)

Question 6 continued

Question 6 continued

Question 6 continued

(Total for Question 6 is 16 marks)

7.

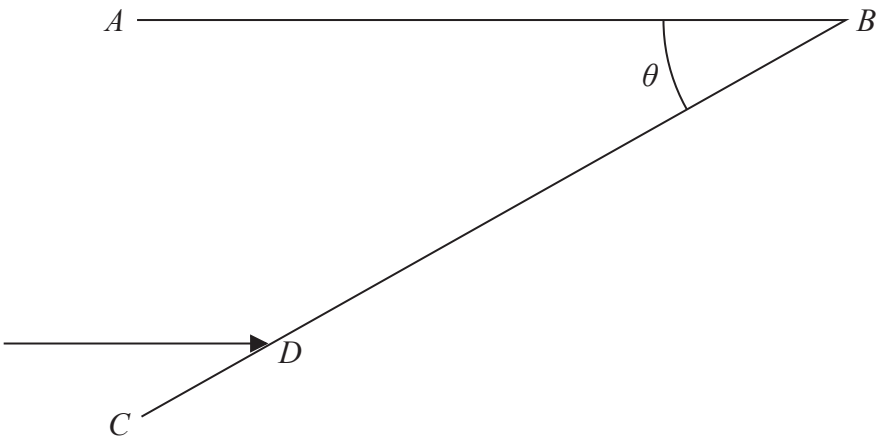

Figure 1

Figure 1 shows a plan view of two smooth fixed vertical walls, AB and BC, which are fixed to smooth horizontal ground. The angle between the walls is θ, where θ is an acute angle. A particle P is moving in a straight line on the ground and hits the wall BC at the point D.

Immediately before P hits the wall BC, P is moving in a direction that is parallel to the wall AB, as shown in Figure 1. Particle P bounces off BC and, after one impact with AB, P then hits BC for a second time. The coefficient of restitution between P and each wall is e.

Given that when P hits BC for a second time, P is moving in a direction that is perpendicular to BC,

(a) show that

$$e(e + 2)\tan^2\theta = 1$$

(10)

(b) Deduce that, for the motion to be possible, the angle between the walls must be at least 30°.

(3)

Question 7 continued

Question 7 continued

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Question 7 continued

Question 7 continued

(Total for Question 7 is 13 marks)

TOTAL FOR PAPER IS 75 MARKS

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