Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number	Candidate Number

A level Further Mathematics
Further Mechanics 1
Practice Paper 1

You must have:
Mathematical Formulae and Statistical Tables (Pink)

Total Marks

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 the 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.
- Inexact answers should be given to three significant figures unless otherwise stated.

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.
- Calculators must not be used for questions marked with a * sign.

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.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

1. A van of mass 900 kg is moving down a straight road that is inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{30}$. The resistance to motion of the van has constant magnitude 570 N. The engine of the van is working at a constant rate of 12.5 kW.

At the instant when the van is moving down the road at 5 m s^{-1}, the acceleration of the van is a m s^{-2}.

Find the value of a.

(Total 5 marks)

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2. A ball of mass 0.4 kg is moving in a horizontal plane when it is struck by a bat. The bat exerts an impulse $(-5\mathbf{i} + 3\mathbf{j})$ N s on the ball. Immediately after receiving the impulse the ball has velocity $(12\mathbf{i} + 15\mathbf{j})$ m s^{-1}.

Find

(a) the speed of the ball immediately before the impact,

(4)

(b) the size of the angle through which the direction of motion of the ball is deflected by the impact.

(3)

(Total 7 marks)

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3. A small smooth ball of mass m is falling vertically when it strikes a fixed smooth plane which is inclined to the horizontal at an angle α, where $0° < \alpha < 45°$. Immediately before striking the plane the ball has speed u. Immediately after striking the plane the ball moves in a direction which makes an angle of 45° with the plane. The coefficient of restitution between the ball and the plane is e. Find, in terms of m, u and e, the magnitude of the impulse of the plane on the ball.

(Total 11 marks)

4.

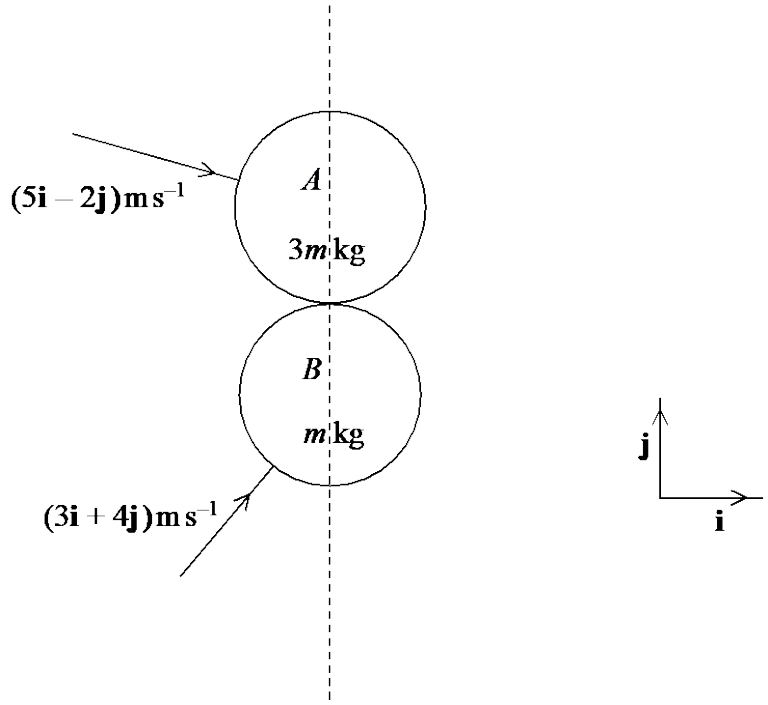

Figure 1

Two smooth uniform spheres A and B have masses $3m$ kg and m kg respectively and equal radii. The spheres are moving on a smooth horizontal surface. Initially, sphere A has velocity $(5\mathbf{i} - 2\mathbf{j})$ m s^{-1} and sphere B has velocity $(3\mathbf{i} + 4\mathbf{j})$ m s^{-1}. When the spheres collide, the line joining their centres is parallel to $\mathbf{j}$, as shown in Figure 1.

The coefficient of restitution between the two spheres is e.

The kinetic energy of sphere B immediately after the collision is 85% of its kinetic energy immediately before the collision.

Find

(a) the velocity of each sphere immediately after the collision,

(9)

(b) the value of e.

(3)

(Total 12 marks)

5. A particle P of mass $2m$ is moving in a straight line with speed $3u$ on a smooth horizontal table. A second particle Q of mass $3m$ is moving in the opposite direction to P along the same straight line with speed u. The particle P collides directly with Q. The direction of motion of P is reversed by the collision. The coefficient of restitution between P and Q is e.

(a) Show that the speed of Q immediately after the collision is $\frac{u}{5}(8e+3)$.

(6)

(b) Find the range of possible values of e.

(4)

The total kinetic energy of the particles before the collision is T. The total kinetic energy of the particles after the collision is kT. Given that $e = \frac{1}{2}$,

(c) find the value of k.

(4)

(Total 14 marks)

6. The ends of a light elastic string, of natural length 0.4 m and modulus of elasticity λ newtons, are attached to two fixed points A and B which are 0.6 m apart on a smooth horizontal table. The tension in the string is 8 N.

(a) Show that $\lambda = 16$

(3)

A particle P is attached to the midpoint of the string. The particle P is now pulled **horizontally** in a direction perpendicular to AB to a point 0.4 m from the midpoint of AB. The particle is held at rest by a **horizontal** force of magnitude F newtons acting in a direction perpendicular to AB, as shown in Figure 5 below.

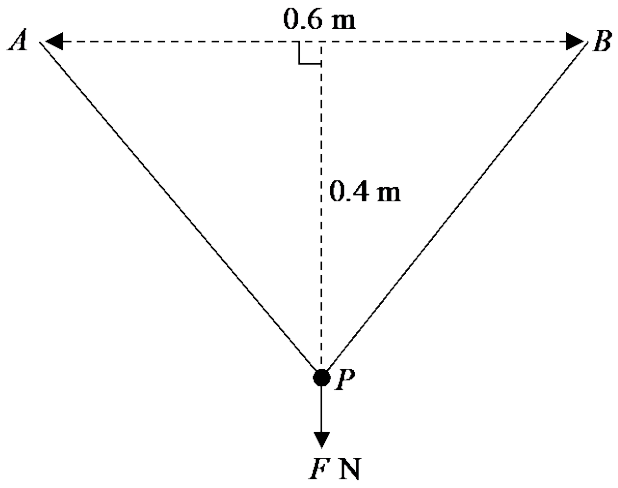

Figure 5

(b) Find the value of F.

(4)

The particle is released from rest. Given that the mass of P is 0.3 kg,

(c) find the speed of P as it crosses the line AB.

(6)

(Total 13 marks)

7.

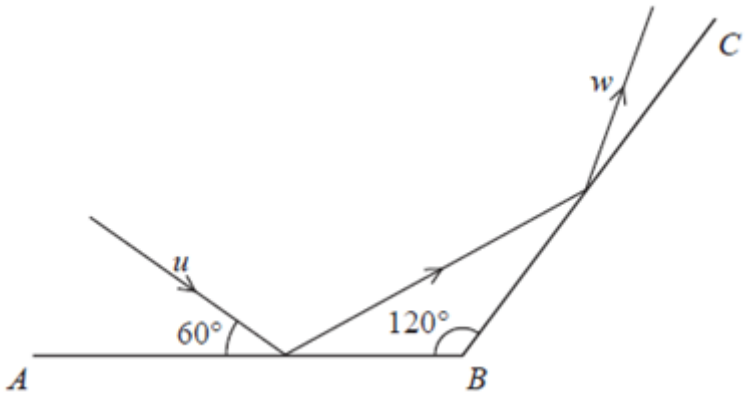

Figure 2

Figure 2 represents the plan view of part of a smooth horizontal floor, where AB and BC are smooth vertical walls. The angle between AB and BC is 120°. A ball is projected along the floor towards AB with speed u m s^{-1} on a path at an angle of 60° to AB. The ball hits AB and then hits BC. The ball is modelled as a particle. The coefficient of restitution between the ball and each wall is $\frac{1}{2}$.

(a) Show that the speed of the ball immediately after it has hit AB is $\frac{\sqrt{7}}{4}u$.

(6)

The speed of the ball immediately after it has hit BC is w m s^{-1}.

(b) Find w in terms of u.

(7)

(Total 13 marks)

TOTAL FOR PAPER: 75 MARKS