Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number	Candidate Number

A level Further Mathematics
Further Mechanics 1
Practice Paper 2

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 particle of mass 0.6 kg is moving with constant velocity $(c\mathbf{i} + 2c\mathbf{j})$ m s^{-1}, where c is a positive constant. The particle receives an impulse of magnitude $2\sqrt{10}$ N s.

Immediately after receiving the impulse the particle has velocity $(2c\mathbf{i} - c\mathbf{j})$ m s^{-1}.

Find the value of c.

(Total 6 marks)

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2. A van of mass 600 kg is moving up a straight road inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{16}$. The resistance to motion of the van from non-gravitational forces has constant magnitude R newtons. When the van is moving at a constant speed of 20 m s^{-1}, the van's engine is working at a constant rate of 25 kW.

(a) Find the value of R.

(4)

The power developed by the van's engine is now increased to 30 kW. The resistance to motion from non-gravitational forces is unchanged. At the instant when the van is moving up the road at 20 m s^{-1}, the acceleration of the van is a m s^{-2}.

(b) Find the value of a.

(4)

(Total 8 marks)

3.

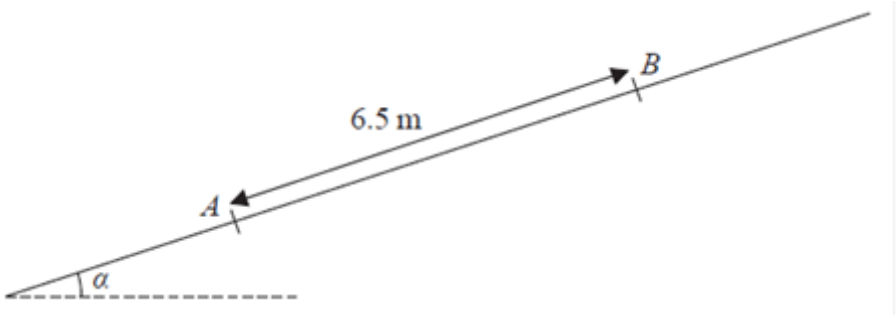

Figure 1

A particle P of mass 10 kg is projected from a point A up a line of greatest slope AB of a fixed rough plane. The plane is inclined at angle α to the horizontal, where $\tan \alpha = \frac{5}{12}$ and $AB = 6.5$ m, as shown in Figure 1. The coefficient of friction between P and the plane is μ. The work done against friction as P moves from A to B is 245 J.

(a) Find the value of μ.

(5)

The particle is projected from A with speed 11.5 m s^{-1}. By using the work-energy principle,

(b) find the speed of the particle as it passes through B.

(4)

(Total 9 marks)

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4. A small ball B, moving on a smooth horizontal plane, collides with a fixed smooth vertical wall. Immediately before the collision the angle between the direction of motion of B and the wall is α. The coefficient of restitution between B and the wall is $\frac{3}{4}$. The kinetic energy of B immediately after the collision is 60% of its kinetic energy immediately before the collision.

Find, in degrees, the size of angle α.

(Total 8 marks)

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5. A particle P of mass $3m$ is moving in a straight line with speed $2u$ on a smooth horizontal table. It collides directly with another particle Q of mass $2m$ which is moving with speed u in the opposite direction to P. The coefficient of restitution between P and Q is e.

(a) Show that the speed of Q immediately after the collision is $\frac{1}{5}(9e + 4)u$.

(5)

The speed of P immediately after the collision is $\frac{1}{2}u$.

(b) Show that $e = \frac{1}{4}$.

(4)

The collision between P and Q takes place at the point A. After the collision Q hits a smooth fixed vertical wall which is at right-angles to the direction of motion of Q. The distance from A to the wall is d.

(c) Show that P is a distance $\frac{3}{5}d$ from the wall at the instant when Q hits the wall.

(4)

Particle Q rebounds from the wall and moves so as to collide directly with particle P at the point B. Given that the coefficient of restitution between Q and the wall is $\frac{1}{5}$,

(d) find, in terms of d, the distance of the point B from the wall.

(4)

(Total 17 marks)

6.

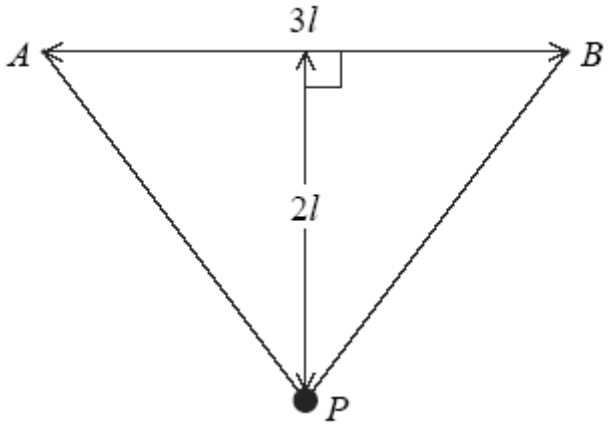

Figure 2

A light elastic string, of natural length $3l$ and modulus of elasticity λ, has its ends attached to two points A and B, where $AB = 3l$ and AB is horizontal. A particle P of mass m is attached to the mid-point of the string. Given that P rests in equilibrium at a distance $2l$ below AB, as shown in Figure 2,

(a) show that $\lambda = \dfrac{15mg}{16}$.

(9)

The particle is pulled vertically downwards from its equilibrium position until the total length of the elastic string is $7.8l$. The particle is released from rest.

(b) Show that P comes to instantaneous rest on the line AB.

(6)

(Total 15 marks)

7.

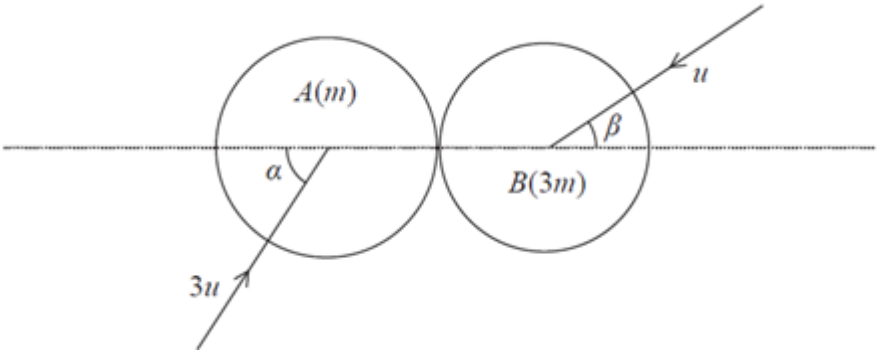

Figure 3

Two smooth uniform spheres A and B have equal radii. The mass of A is m and the mass of B is $3m$. The spheres are moving on a smooth horizontal plane when they collide obliquely. Immediately before the collision, A is moving with speed $3u$ at angle α to the line of centres and B is moving with speed u at angle β to the line of centres, as shown in Figure 3. The coefficient of restitution between the two spheres is $\frac{1}{5}$. It is given that $\cos \alpha = \frac{1}{3}$ and $\cos \beta = \frac{2}{3}$ and that α and β are both acute angles.

(a) Find the magnitude of the impulse on A due to the collision in terms of m and u.

(8)

(b) Express the kinetic energy lost by A in the collision as a fraction of its initial kinetic energy.

(4)

(Total 12 marks)

TOTAL FOR PAPER: 75 MARKS