Write your name here

Surname | Other names

Pearson Edexcel GCE

Centre Number | Candidate Number

A level Further Mathematics

Further Mechanics 1

Practice Paper 5

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 truck of mass 750 kg is moving with constant speed v m s^{-1} down a straight road inclined at an angle θ to the horizontal, where $\sin\theta = \frac{3}{49}$. The resistance to motion of the truck is modelled as a constant force of magnitude 1200 N. The engine of the truck is working at a constant rate of 9 kW.

(a) Find the value of v.

(4)

On another occasion the truck is moving up the same straight road. The resistance to motion of the truck from non-gravitational forces is modelled as a constant force of magnitude 1200N. The engine of the truck is working at a constant rate of 9 kW.

(b) Find the acceleration of the truck at the instant when it is moving with speed 4.5 m s^{-1}.

(4)

(Total 8 marks)

2.

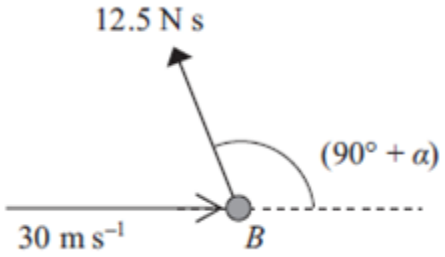

Figure 1

A small ball B of mass 0.25 kg is moving in a straight line with speed 30 m s^{-1} on a smooth horizontal plane when it is given an impulse. The impulse has magnitude 12.5 N s and is applied in a horizontal direction making an angle of $(90° + \alpha)$, where $\tan\alpha = \frac{3}{4}$, with the initial direction of motion of the ball, as shown in Figure 1.

(i) Find the speed of B immediately after the impulse is applied.

(ii) Find the direction of motion of B immediately after the impulse is applied.

(Total 6 marks)

3.

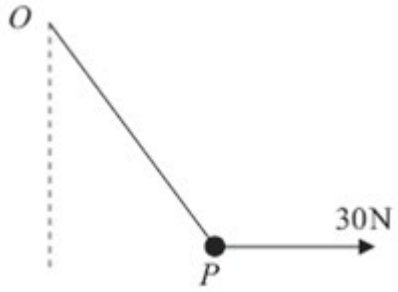

Figure 2

A particle P of weight 40 N is attached to one end of a light elastic string of natural length 0.5 m. The other end of the string is attached to a fixed point O. A horizontal force of magnitude 30 N is applied to P, as shown in Figure 2. The particle P is in equilibrium and the elastic energy stored in the string is 10 J.

Calculate the length OP.

(Total 10 marks)

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4. [*In this question, the unit vectors* **i** *and* **j** *are in a vertical plane*, **i** *being horizontal and* **j** *being vertically upwards*.]

A line of greatest slope of a fixed smooth plane is parallel to the vector $(-4\mathbf{i} - 3\mathbf{j})$.
A particle P falls vertically and strikes the plane. Immediately before the impact, P has velocity $-7\mathbf{j}$ m s^{-1}. Immediately after the impact, P has velocity $(-a\mathbf{i} + \mathbf{j})$ m s^{-1}, where a is a positive constant.

(a) Show that $a = 6$

(2)

(b) Find the coefficient of restitution between P and the plane.

(6)

(Total 8 marks)

5.

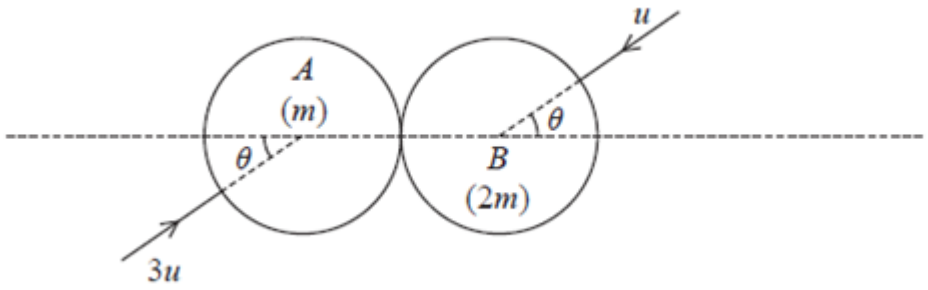

Figure 3

Two smooth uniform spheres A and B with equal radii have masses m and $2m$ respectively. The spheres are moving in opposite directions on a smooth horizontal surface and collide obliquely. Immediately before the collision, A has speed $3u$ with its direction of motion at an angle θ to the line of centres, and B has speed u with its direction of motion at an angle θ to the line of centres, as shown in Figure 3. The coefficient of restitution between the spheres is $\frac{1}{8}$.

Immediately after the collision, the speed of A is twice the speed of B.

Find the size of the angle θ.

(Total 12 marks)

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6. A light elastic string has natural length a and modulus of elasticity $\frac{3}{2}mg$. A particle P of mass m is attached to one end of the string. The other end of the string is attached to a fixed point A. The particle is released from rest at A and falls vertically. When P has fallen a distance $a + x$, where $x > 0$, the speed of P is v.

(a) Show that

$$v^2 = 2g(a + x) - \frac{3gx^2}{2a}.$$

(4)

(b) Find the greatest speed attained by P as it falls.

(4)

After release, P next comes to instantaneous rest at a point D.

(c) Find the magnitude of the acceleration of P at D.

(6)

(Total 14 marks)

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7. A particle P of mass $2m$ is moving with speed $2u$ in a straight line on a smooth horizontal plane. A particle Q of mass $3m$ is moving with speed u in the same direction as P. The particles collide directly. The coefficient of restitution between P and Q is $\frac{1}{2}$.

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

(5)

(b) Find the total kinetic energy lost in the collision.

(5)

After the collision between P and Q, the particle Q collides directly with a particle R of mass m which is at rest on the plane. The coefficient of restitution between Q and R is e.

(c) Calculate the range of values of e for which there will be a second collision between P and Q.

(7)

(Total 17 marks)

TOTAL FOR PAPER: 75 MARKS