Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel GCE

Centre Number | | | | | |

Candidate Number | | | | |

Friday 14 June 2019

Afternoon (Time: 1 hour 30 minutes) | Paper Reference **6678/01**

Mechanics M2

Advanced/Advanced Subsidiary

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

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). Coloured pencils and highlighter pens must not be used.
- **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.
- Whenever a numerical value of g is required, take $g = 9.8$ m s^{-2}, and give your answer to either two significant figures or three significant figures.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information

- 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.

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1. A van of mass 800 kg is moving up a straight road which is inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{7}$. The engine of the van is working at a constant rate of 18 kW.

At the instant when the speed of the van is $15\,\text{m s}^{-1}$, the deceleration of the van is $0.75\,\text{m s}^{-2}$. The resistance to motion of the van from non-gravitational forces is modelled as a constant force of magnitude R newtons.

Find the value of R.

(5)

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Question 1 continued

Q1

(Total 5 marks)

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2. A particle P of mass 4 kg is moving with velocity $3.5\mathbf{i}$ m s^{-1} when it receives an impulse of magnitude 26 Ns. Immediately after receiving the impulse the velocity of P is $w(\mathbf{i} + \mathbf{j})$ m s^{-1}, where w is a positive constant.

Find the value of w.

(5)

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Question 2 continued

Q2

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3. A particle P moves on the x-axis. At time t seconds, $t \geqslant 0$, the displacement of P from the origin O in the positive x direction is x metres, where $x = \frac{4}{3}t^3 - 3t^2 - 4t$.

Find

(a) the value of t when P is instantaneously at rest,

(4)

(b) the acceleration of P when $t = 3$

(3)

(c) the distance travelled by P in the interval $0 \leqslant t \leqslant 3$

(3)

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Question 3 continued

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Q3

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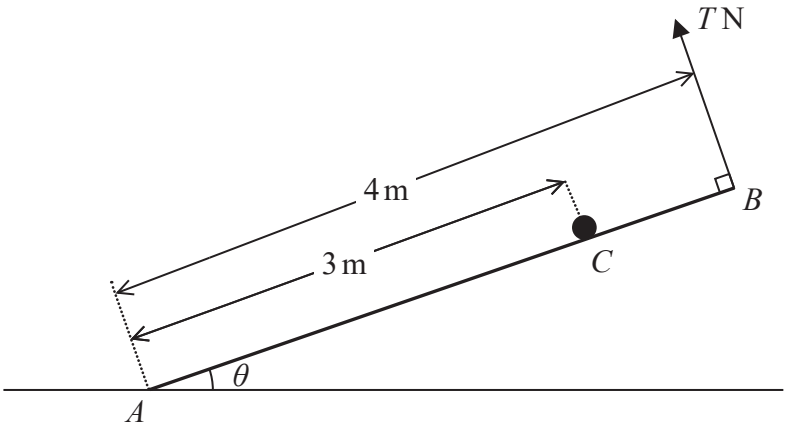

Figure 1

A uniform rod AB, of weight 50 N and length 4 m, rests with one end A on rough horizontal ground. A particle of weight 10 N is attached to the rod at C, where $AC = 3$ m. The rod is held in limiting equilibrium at an angle θ to the horizontal, where $\tan\theta = \frac{5}{12}$, by a force of magnitude T newtons. This force acts in a direction perpendicular to the rod at B, as shown in Figure 1. The line of action of the force lies in the same vertical plane as the rod. The coefficient of friction between the ground and the rod is μ.

Find

(a) the value of T,

(3)

(b) the value of μ.

(6)

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Question 4 continued

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Question 4 continued

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Question 4 continued

Q4

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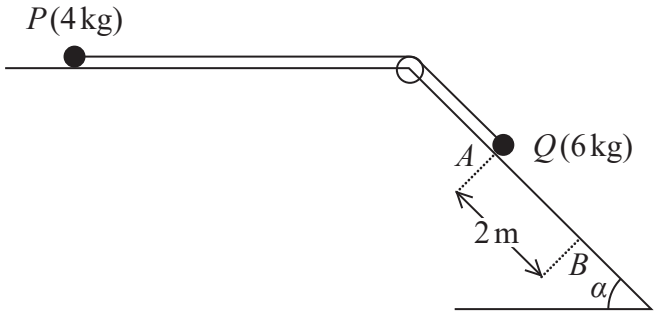

Figure 2

Two particles, P and Q, of masses 4 kg and 6 kg respectively, are connected by a light inextensible string. The string passes over a small smooth pulley which is fixed at a point on the line of intersection of a fixed rough horizontal plane and a fixed smooth inclined plane. The string lies in a vertical plane that contains a line of greatest slope of the inclined plane. The inclined plane is at an angle α to the horizontal, where $\tan\alpha = 2$. The particles are held at rest, with the string taut, so that P is on the horizontal plane and Q is at the point A on the inclined plane. The point B, which is on the line of greatest slope of the plane through A, is 2 m down the plane from A, as shown in Figure 2.

The particles are released from rest and Q moves down the inclined plane. At the instant when Q is at B, the speed of Q is $3\,\text{m s}^{-1}$ and P has not reached the pulley.

(a) Find the kinetic energy gained by the system as Q moves from A to B.

(2)

(b) Using the work-energy principle, find the coefficient of friction between P and the horizontal plane.

(6)

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Question 5 continued

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Question 5 continued

Q5

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6. Two particles, A and B, of masses $2m$ and $3m$ respectively, lie on a smooth horizontal surface. Particle B lies between particle A and a fixed smooth vertical wall. The particles are set in motion in the same direction, along the same straight line, towards the wall. The speed of A is u and the speed of B is $2u$. Particle B hits the wall, which is perpendicular to the direction of motion of the particles. Particle B rebounds and there is then a direct collision between A and B. The coefficient of restitution between B and the wall is e.

The coefficient of restitution between A and B is $\frac{1}{3}$.

In the collision between A and B, the directions of motion of both particles are reversed.

Find the range of possible values for e.

(11)

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Question 6 continued

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Q6

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

At time $t = 0$, a particle P is projected from a fixed origin O with velocity $(4\mathbf{i} + 7\mathbf{j})$ m s^{-1}. The particle moves freely under gravity. At time T seconds, P passes through the point A with velocity $\lambda(\mathbf{i} - 2\mathbf{j})$ m s^{-1}, where λ is a positive constant.

Find

(a) the value of T,

(3)

(b) the distance OA.

(5)

When P is at the point B, the direction of motion of P is perpendicular to the initial direction of motion of P.

(c) Find the velocity of P when it is at B.

(4)

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Question 7 continued

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Q7

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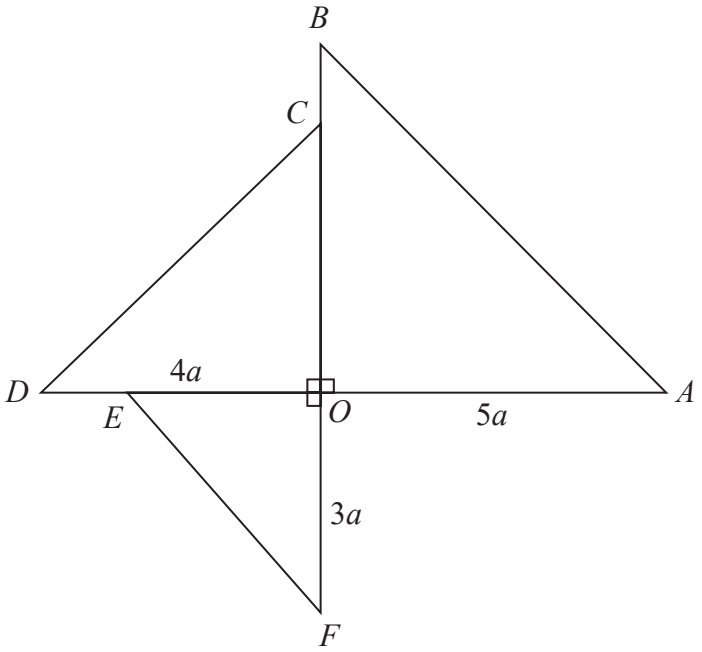

Figure 3

The uniform plane lamina L, shown in Figure 3, is made from three right-angled isosceles triangles, OAB, OCD and OEF, all of the same material. The triangles have sides $OA = OB = 5a$, $OC = OD = 4a$ and $OE = OF = 3a$. The point C lies on OB and the point E lies on OD.

(a) Show that the centre of mass of L is $\frac{27}{25}a$ from AD.

(5)

The lamina L is freely suspended from A and hangs in equilibrium.

(b) Find the size of the angle between AD and the downward vertical.

(7)

The mass of L is $50M$. A particle of mass kM is attached to L at the point F so that, when L is suspended from A, the line AD is vertical.

(c) Find the value of k.

(3)

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Question 8 continued

Q8

(Total 15 marks)

TOTAL FOR PAPER: 75 MARKS

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