Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Mechanics M1

Advanced/Advanced Subsidiary

Monday 25 January 2016 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
WME01/01

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

Total Marks

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. 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 truck of mass 2400 kg is pulling a trailer of mass M kg along a straight horizontal road. The tow bar, connecting the truck to the trailer, is horizontal and parallel to the direction of motion. The tow bar is modelled as being light and inextensible. The resistance forces acting on the truck and the trailer are constant and of magnitude 400 N and 200 N respectively. The acceleration of the truck is 0.5 m s^{-2} and the tension in the tow bar is 600 N.

(a) Find the magnitude of the driving force of the truck.

(3)

(b) Find the value of M.

(3)

(c) Explain how you have used the fact that the tow bar is inextensible in your calculations.

(1)

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Question 1 continued

Q1

(Total 7 marks)

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2. Two particles P and Q are moving in opposite directions along the same horizontal straight line. Particle P is moving due east and particle Q is moving due west. Particle P has mass $2m$ and particle Q has mass $3m$. The particles collide directly. Immediately before the collision, the speed of P is $4u$ and the speed of Q is u. The magnitude of the impulse in the collision is $\frac{33}{5}mu$.

(a) Find the speed and direction of motion of P immediately after the collision.

(4)

(b) Find the speed and direction of motion of Q immediately after the collision.

(4)

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Question 2 continued

Q2

(Total 8 marks)

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3.

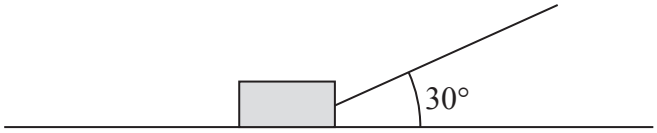

Figure 1

A boy is pulling a sledge of mass 8 kg in a straight line at a constant speed across rough horizontal ground by means of a rope. The rope is inclined at 30° to the ground, as shown in Figure 1. The coefficient of friction between the sledge and the ground is $\frac{1}{5}$. By modelling the sledge as a particle and the rope as a light inextensible string, find the tension in the rope.

(8)

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Question 3 continued

Q3

(Total 8 marks)

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4. A small stone is projected vertically upwards from the point O and moves freely under gravity. The point A is 3.6 m vertically above O. When the stone first reaches A, the stone is moving upwards with speed 11.2 m s^{-1}. The stone is modelled as a particle.

(a) Find the maximum height above O reached by the stone.

(4)

(b) Find the total time between the instant when the stone was projected from O and the instant when it returns to O.

(5)

(c) Sketch a velocity-time graph to represent the motion of the stone from the instant when it passes through A moving upwards to the instant when it returns to O. Show, on the axes, the coordinates of the points where your graph meets the axes.

(4)

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Question 4 continued

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Question 4 continued

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Question 4 continued

(Total 13 marks)

Q4

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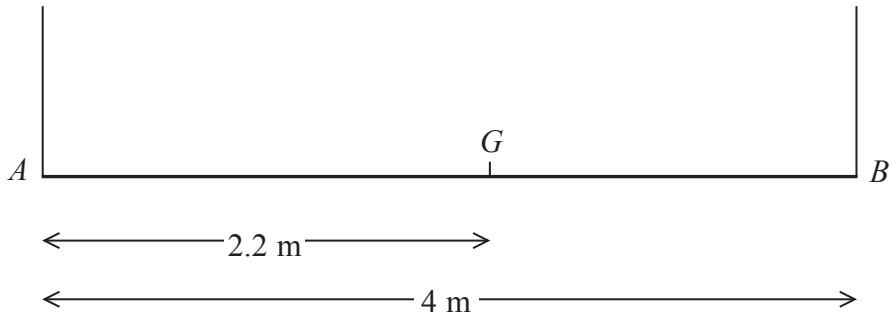

Figure 2

A non-uniform rod AB has length 4 m and weight 120 N. The centre of mass of the rod is at the point G where $AG = 2.2$ m. The rod is suspended in a horizontal position by two vertical light inextensible strings, one at each end, as shown in Figure 2. A particle of weight 40 N is placed on the rod at the point P, where $AP = x$ metres. The rod remains horizontal and in equilibrium.

(a) Find, in terms of x,

(i) the tension in the string at A,

(ii) the tension in the string at B.

(6)

Either string will break if the tension in it exceeds 84 N.

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

(4)

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Question 5 continued

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Question 5 continued

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Question 5 continued

(Total 10 marks)

Q5

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6. [*In this question* **i** and **j** *are horizontal unit vectors due east and due north respectively and position vectors are given relative to a fixed origin.*]

At 2 pm, the position vector of ship P is $(5\mathbf{i} - 3\mathbf{j})$ km and the position vector of ship Q is $(7\mathbf{i} + 5\mathbf{j})$ km.

(a) Find the distance between P and Q at 2 pm.

(3)

Ship P is moving with constant velocity $(2\mathbf{i} + 5\mathbf{j})$ km h^{-1} and ship Q is moving with constant velocity $(-3\mathbf{i} - 15\mathbf{j})$ km h^{-1}.

(b) Find the position vector of P at time t hours after 2 pm.

(2)

(c) Find the position vector of Q at time t hours after 2 pm.

(1)

(d) Show that Q will meet P and find the time at which they meet.

(5)

(e) Find the position vector of the point at which they meet.

(2)

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Question 6 continued

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Question 6 continued

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Question 6 continued

Q6

(Total 13 marks)

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7.

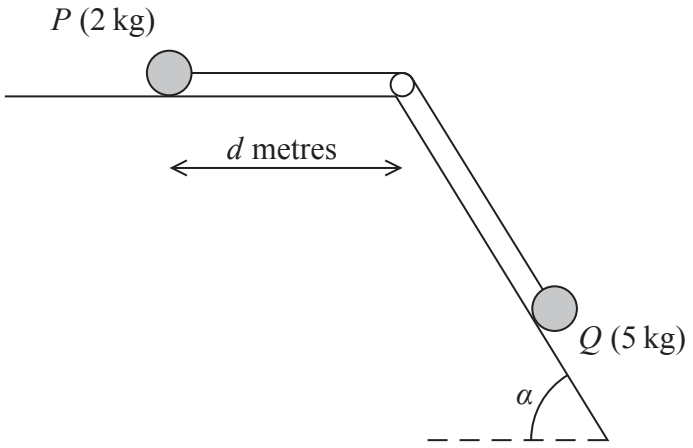

Figure 3

A particle P of mass 2 kg is attached to one end of a light inextensible string. A particle Q of mass 5 kg is attached to the other end of the string. The string passes over a small smooth light pulley. The pulley is fixed at a point on the intersection of a rough horizontal table and a fixed smooth inclined plane. The string lies along the table and also lies in a vertical plane which contains a line of greatest slope of the inclined plane. This plane is inclined to the horizontal at an angle α, where $\tan\alpha = \frac{3}{4}$. Particle P is at rest on the table, a distance d metres from the pulley. Particle Q is on the inclined plane with the string taut, as shown in Figure 3. The coefficient of friction between P and the table is $\frac{1}{4}$.

The system is released from rest and P slides along the table towards the pulley.

Assuming that P has not reached the pulley and that Q remains on the inclined plane,

(a) write down an equation of motion for P,

(2)

(b) write down an equation of motion for Q,

(2)

(c) (i) find the acceleration of P,

(ii) find the tension in the string.

(5)

When P has moved a distance 0.5 m from its initial position, the string breaks. Given that P comes to rest just as it reaches the pulley,

(d) find the value of d.

(7)

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Question 7 continued

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Question 7 continued

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Question 7 continued

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Question 7 continued

Q7

(Total 16 marks)

TOTAL FOR PAPER: 75 MARKS

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