Write your name here

Surname	Other names

Pearson Edexcel International Advanced Level

Centre Number | Candidate Number

Mechanics M1

Advanced/Advanced Subsidiary

Wednesday 22 January 2014 – Morning
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.

Turn over

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P 4 3 0 1 2 A 0 1 2 8

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1. A truck P of mass $2M$ is moving with speed U on smooth straight horizontal rails. It collides directly with another truck Q of mass $3M$ which is moving with speed $4U$ in the opposite direction on the same rails. The trucks join so that immediately after the collision they move together. By modelling the trucks as particles, find

(a) the speed of the trucks immediately after the collision,

(3)

(b) the magnitude of the impulse exerted on P by Q in the collision.

(3)

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Question 1 continued

Q1

(Total 6 marks)

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2. A particle P is moving with constant velocity $(2\mathbf{i} - 3\mathbf{j})$ m s^{-1}.

(a) Find the speed of P.

(2)

The particle P passes through the point A and 4 seconds later passes through the point with position vector $(\mathbf{i} - 4\mathbf{j})$ m.

(b) Find the position vector of A.

(4)

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Question 2 continued

Q2

(Total 6 marks)

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3. A beam AB has length 15 m and mass 25 kg. The beam is smoothly supported at the point P, where $AP = 8$ m. A man of mass 100 kg stands on the beam at a distance of 2 m from A and another man stands on the beam at a distance of 1 m from B. The beam is modelled as a non-uniform rod and the men are modelled as particles. The beam is in equilibrium in a horizontal position with the reaction on the beam at P having magnitude 2009 N. Find the distance of the centre of mass of the beam from A.

(5)

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Question 3 continued

Q3

(Total 5 marks)

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4.

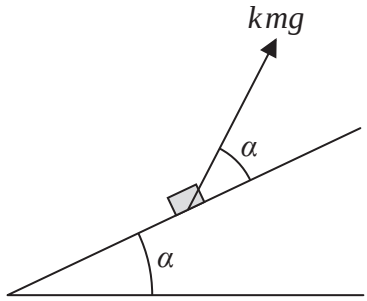

Figure 1

A fixed rough plane is inclined to the horizontal at an angle α, where $\tan\alpha = \frac{3}{4}$

A small box of mass m is at rest on the plane. A force of magnitude kmg, where k is a constant, is applied to the box. The line of action of the force is at angle α to the line of greatest slope of the plane through the box, as shown in Figure 1, and lies in the same vertical plane as this line of greatest slope. The coefficient of friction between the box and the plane is μ. The box is on the point of slipping up the plane. By modelling the box as a particle, find k in terms of μ.

(11)

P 4 3 0 1 2 A 0 8 2 8

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Question 4 continued

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Question 4 continued

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Question 4 continued

Q4

(Total 11 marks)

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5. A racing car is moving along a straight horizontal track with constant acceleration. There are three checkpoints, P, Q and R, on the track, where $PQ = 48$ m and $QR = 200$ m. The car takes 3 s to travel from P to Q and 5 s to travel from Q to R. Find

(i) the acceleration of the car,

(ii) the speed of the car as it passes P.

(7)

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Question 5 continued

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Question 5 continued

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Question 5 continued

Q5

(Total 7 marks)

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6.

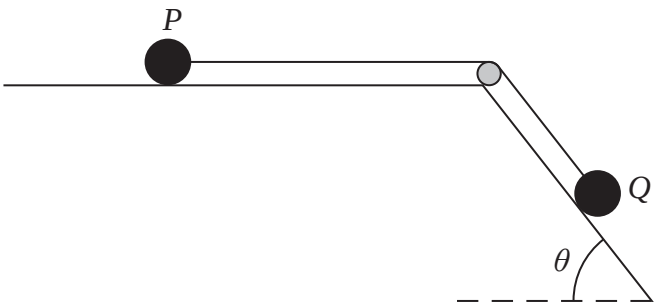

Figure 2

Two particles P and Q have masses 0.1 kg and 0.5 kg respectively. The particles are attached to the ends of a light inextensible string. Particle P is held at rest on a rough horizontal table. The string lies along the table and passes over a small smooth pulley which is fixed to the edge of the table. Particle Q is at rest on a smooth plane which is inclined to the horizontal at an angle θ, where $\tan\theta = \frac{4}{3}$

The string lies in the vertical plane which contains the pulley and a line of greatest slope of the inclined plane, as shown in Figure 2. Particle P is released from rest with the string taut. During the first 0.5 s of the motion P does not reach the pulley and Q moves 0.75 m down the plane.

(a) Find the tension in the string during the first 0.5 s of the motion.

(6)

(b) Find the coefficient of friction between P and the table.

(5)

P 4 3 0 1 2 A 0 1 6 2 8

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Question 6 continued

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Question 6 continued

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Question 6 continued

Q6

(Total 11 marks)

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7. A force **F** is given by **F** = (9**i** + 13**j**) N.

(a) Find the size of the angle between the direction of **F** and the vector **j**.

(3)

The force **F** is the resultant of two forces **P** and **Q**. The line of action of **P** is parallel to the vector (2**i** – **j**). The line of action of **Q** is parallel to the vector (**i** + 3**j**).

(b) Find, in terms of **i** and **j**,

(i) the force **P**,

(ii) the force **Q**.

(9)

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Question 7 continued

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Question 7 continued

Leave blank

Question 7 continued

Q7

(Total 12 marks)

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8. Two trains, A and B, start together from rest, at time $t = 0$, at a station and move along parallel straight horizontal tracks. Both trains come to rest at the next station after 180 s.

Train A moves with constant acceleration $\frac{2}{3}$ m s^{-2} for 30 s, then moves at constant speed for 120 s and then moves with constant deceleration for the final 30 s. Train B moves with constant acceleration for 90 s and then moves with constant deceleration for the final 90 s.

(a) Sketch, on the same axes, the speed–time graphs for the motion of the two trains between the two stations.

(3)

(b) Find the acceleration of train B for the first half of its journey.

(5)

(c) Find the times when the two trains are moving at the same speed.

(4)

(d) Find the distance between the trains 96 s after they start.

(5)

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Question 8 continued

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Question 8 continued

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Question 8 continued

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Question 8 continued

Q8

(Total 17 marks)

TOTAL FOR PAPER: 75 MARKS

END