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Candidate Number

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Mechanics M1

Advanced/Advanced Subsidiary

Wednesday 8 June 2016 – Morning
Time: 1 hour 30 minutes

Paper Reference

6677/01**You must have:**

Mathematical Formulae and Statistical Tables (Pink)

Total Marks

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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 $g = 9.8 \text{ m s}^{-2}$, 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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- 4. Two trains M and N are moving in the same direction along parallel straight horizontal tracks. At time $t = 0$, M overtakes N whilst they are travelling with speeds 40 m s^{-1} and 30 m s^{-1} respectively. Train M overtakes train N as they pass a point X at the side of the tracks.

After overtaking N , train M maintains its speed of 40 m s^{-1} for T seconds and then decelerates uniformly, coming to rest next to a point Y at the side of the tracks.

After being overtaken, train N maintains its speed of 30 m s^{-1} for 25 s and then decelerates uniformly, also coming to rest next to the point Y .

The times taken by the trains to travel between X and Y are the same.

- (a) Sketch, on the same diagram, the speed-time graphs for the motions of the two trains between X and Y . (4)

Given that $XY = 975 \text{ m}$,

- (b) find the value of T . (8)



5.

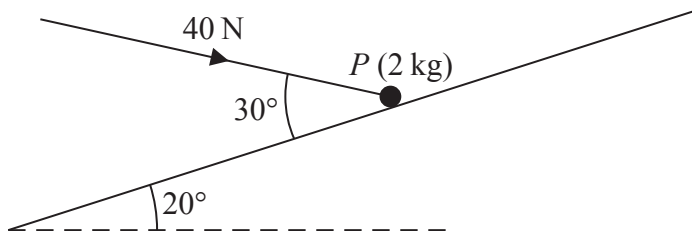


Figure 2

A particle P of mass 2 kg is held at rest in equilibrium on a rough plane by a constant force of magnitude 40 N . The direction of the force is inclined to the plane at an angle of 30° . The plane is inclined to the horizontal at an angle of 20° , as shown in Figure 2. The line of action of the force lies in the vertical plane containing P and a line of greatest slope of the plane. The coefficient of friction between P and the plane is μ .

Given that P is on the point of sliding up the plane, find the value of μ .

(10)

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Question 5 continued

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6. A non-uniform plank AB has length 6 m and mass 30 kg. The plank rests in equilibrium in a horizontal position on supports at the points S and T of the plank where $AS = 0.5$ m and $TB = 2$ m.

When a block of mass M kg is placed on the plank at A , the plank remains horizontal and in equilibrium and the plank is on the point of tilting about S .

When the block is moved to B , the plank remains horizontal and in equilibrium and the plank is on the point of tilting about T .

The distance of the centre of mass of the plank from A is d metres. The block is modelled as a particle and the plank is modelled as a non-uniform rod. Find

- (i) the value of d ,
 - (ii) the value of M .
- (7)**



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Question 6 continued

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Q6

(Total 7 marks)



7. Two forces \mathbf{F}_1 and \mathbf{F}_2 act on a particle P .

The force \mathbf{F}_1 is given by $\mathbf{F}_1 = (-\mathbf{i} + 2\mathbf{j})$ N and \mathbf{F}_2 acts in the direction of the vector $(\mathbf{i} + \mathbf{j})$.

Given that the resultant of \mathbf{F}_1 and \mathbf{F}_2 acts in the direction of the vector $(\mathbf{i} + 3\mathbf{j})$,

(a) find \mathbf{F}_2 (7)

The acceleration of P is $(3\mathbf{i} + 9\mathbf{j})$ m s⁻². At time $t = 0$, the velocity of P is $(3\mathbf{i} - 22\mathbf{j})$ m s⁻¹

(b) Find the speed of P when $t = 3$ seconds. (4)

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Question 7 continued

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8.

**Figure 3**

Two particles P and Q have masses 1.5 kg and 3 kg respectively. The particles are attached to the ends of a light inextensible string. Particle P is held at rest on a fixed rough horizontal table. The coefficient of friction between P and the table is $\frac{1}{5}$. The string is parallel to the table and passes over a small smooth light pulley which is fixed at the edge of the table. Particle Q hangs freely at rest vertically below the pulley, as shown in Figure 3. Particle P is released from rest with the string taut and slides along the table.

Assuming that P has not reached the pulley, find

- (a) the tension in the string during the motion, (8)
- (b) the magnitude and direction of the resultant force exerted on the pulley by the string. (4)

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Question 8 continued

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