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CAMBRIDGE A LEVEL PROGRAMME

A2 TRIAL EXAMINATION AUGUST 2011

(June 2010 Intake)

Friday **19 August 2011** **8.30 am – 9.45 am**

MATHEMATICS 9709/43

PAPER 4 Mechanics 1 (M1) 1 hour 15 minutes

Additional materials: Answer Booklet/Paper
List of formulae (MF9)

READ THESE INSTRUCTIONS FIRST

If you have been given an Answer Booklet, follow the instructions on the front cover of the Booklet.
Write your name and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
Where a numerical value for the acceleration due to gravity is needed, use 10 ms^{-2}.
At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total marks for this paper is 50.
Questions carrying smaller numbers of marks are printed earlier in the paper, and questions carrying larger numbers of marks later in the paper.
The use of an electronic calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

This document consists of **4** printed pages.

[Turn over

1 The combined weight of a cyclist and his machine is 850 N. When riding, the resistance force is 62 N. By treating the cyclist and his machine as a particle, find the maximum speed which can be achieved by working at 30 W down a hill with slope of $\sin^{-1}$=0.07.

[4]

2 Two forces X and Y act at a point O and are at right angle to each other. X has magnitude 12 N and acts along a bearing of 090°. Y has magnitude 15 N and acts along a bearing of 000°.

(i) Calculate the magnitude and bearing of the resultant of X and Y. [3]

(ii) A third force E is now applied at O. The three forces X, Y and E are in equilibrium. State the magnitude of E, and give the bearing along which it acts. [2]

3 A particle is moving in a straight line. The velocity vms^{-1} at time t s after the vehicle starts is given by

$$v = A(10t - 2t^2) \qquad for\ 0 \leq t \leq 4$$

$$v = \frac{B}{t^2} + 2 \qquad for\ t \geq 4$$

when A and B are constants. The distance travelled by the vehicle between t = 0 and t = 4 is 10 m.

(i) Find the value of A and show that B is $\frac{16}{7}$. [4]

(ii) Find an expression in terms of t for the total distance travelled by the vehicle when $t \geq 4$. [3]

4 A particle of mass m is placed on a rough plane inclined at an angle $tan^{-1}(\frac{3}{4})$ to the horizontal. The coefficient of friction between the particle and the plane is $\frac{1}{3}$. A horizontal force P, directed towards the plane, acts on the particle. Prove that the particle remains stationary provided that $\frac{1}{3}mg \leq P \leq \frac{13}{9}mg$. [7]

5 Two particles P and Q, of mass 0.3 kg and 0.7 kg respectively, are attached to the ends of a light inextensible string. The string passes over a small, smooth pulley fixed at a height of 2.5 m above horizontal ground. Initially both parts of the string are taut and vertical, with P resting on the ground and Q held at a height of 2 m above the ground. At time $t = 0$, Q is released from rest and the system then moves freely under gravity with the string taut.

(i) Find the tension in the string. [2]

(ii) Show that, when $t = 0.5$ s, Q has fallen a distance of 0.5 m. [2]

At the instant when $t = 0.5$ s, part of Q becomes detached, leaving a particle Q' of mass 0.2 kg attached to the string and with unchanged velocity. Find,

(iii) the minimum height above the ground reached by Q'. [4]

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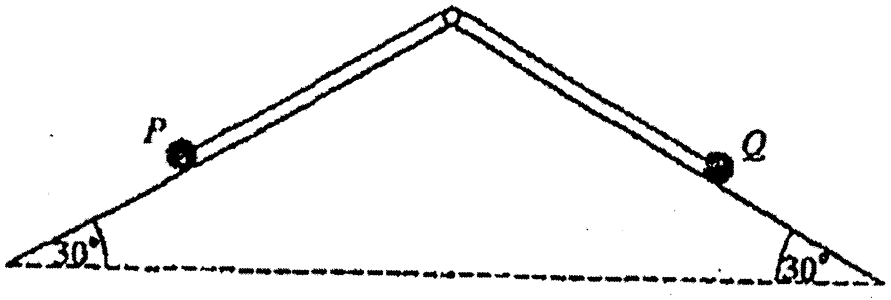

Two particles ***P*** and ***Q***, of mass $4m$ and m respectively are joined by a light inextensible string of length $4l$ passing over a smooth peg, as shown in the figure. The planes are inclined at an angle $30°$ to the horizontal and equally rough with the coefficient of friction between each particle and the plane is $\frac{1}{6}\sqrt{3}$. The system is released from rest with the parts of the string between the peg and the particles taut and parallel to lines of greatest slope. All resistance to motion, apart from friction between the particles and the planes are negligible. The particle ***P*** was initially at the pulley.

(i) Show that the acceleration is $0.5\ ms^{-2}$ when the particles are released. [4]

When the particles are at the same horizontal level, the string will breaks. Find in terms of l,

(ii) the speed of each particle at this instant. [2]

(iii) the speed of the particle ***P*** when it reaches the lowest point on the plane. [3]

[Turn over

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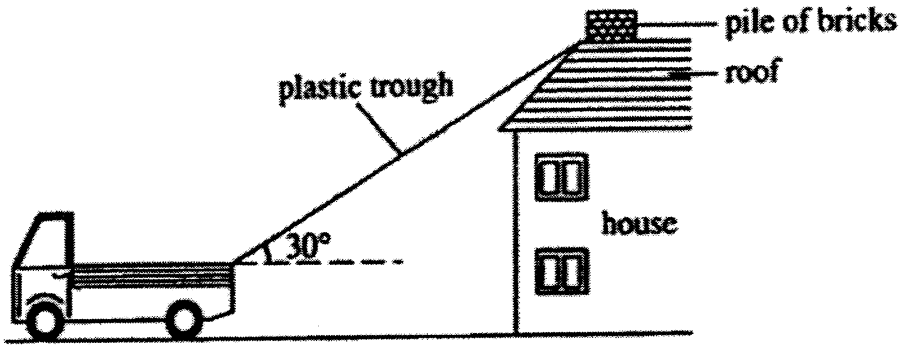

A builder is demolishing a chimney stack. As he takes off the bricks he gets them to his truck by letting them slide 6 m down a plastics trough inclined at 30^0 to the horizontal. The builder releases a brick of mass 3.5 kg from the rest at the top of the trough. When it reaches the bottom, having slid 6 m, its speed is 5 ms^{-1}. Calculate

(i) the potential energy lost by the brick. [2]

(ii) the frictional force (assume to be constant) which acts on the brick whilst it is sliding. [4]

(iii) the coefficient of friction between the brick and the trough. [2]

The builder pushes a similar brick down the trough, giving it an initial speed of 2 ms^{-1}. [2]

(iv) What is the speed of the brick when it has slid 6 m?