UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

MATHEMATICS **9709/41**

Paper 4 Mechanics 1 **(M1)** **October/November 2012**

1 hour 15 minutes

Additional Materials: Answer Booklet/Paper
Graph Paper
List of Formulae (MF9)

* 4 4 1 5 6 9 0 5 8 9 *

READ THESE INSTRUCTIONS FIRST

If you have been given an Answer Booklet, follow the instructions on the front cover of the Booklet.
Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
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 $10\,\text{m}\,\text{s}^{-2}$.
The use of an electronic calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

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 number of 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.

This document consists of **3** printed pages and **1** blank page.

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1 An object is released from rest at a height of 125 m above horizontal ground and falls freely under gravity, hitting a moving target P. The target P is moving on the ground in a straight line, with constant acceleration $0.8\,\text{m s}^{-2}$. At the instant the object is released P passes through a point O with speed $5\,\text{m s}^{-1}$. Find the distance from O to the point where P is hit by the object. [4]

2

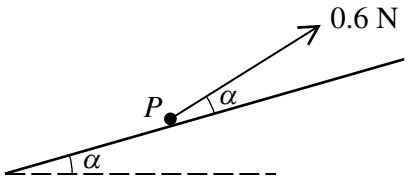


Particles A and B, of masses 0.3 kg and 0.2 kg respectively, are attached to the ends of a light inextensible string. A is held at rest on a rough horizontal table with the string passing over a small smooth pulley at the edge of the table. B hangs vertically below the pulley (see diagram). The system is released and B starts to move downwards with acceleration $1.6\,\text{m s}^{-2}$. Find

(i) the tension in the string after the system is released, [2]

(ii) the frictional force acting on A. [3]

3



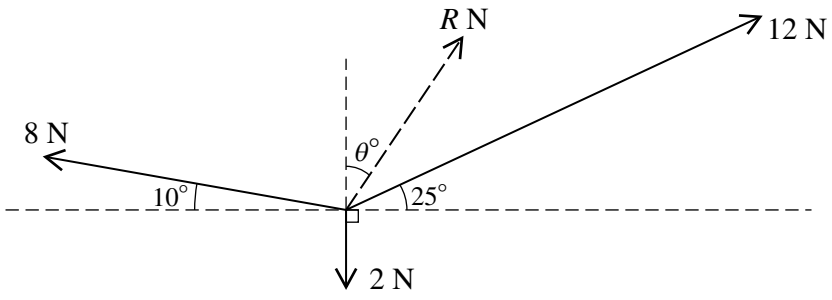
A particle P of mass 0.5 kg rests on a rough plane inclined at angle α to the horizontal, where $\sin\alpha = 0.28$. A force of magnitude 0.6 N, acting upwards on P at angle α from a line of greatest slope of the plane, is just sufficient to prevent P sliding down the plane (see diagram). Find

(i) the normal component of the contact force on P, [2]

(ii) the frictional component of the contact force on P, [3]

(iii) the coefficient of friction between P and the plane. [2]

4



Three coplanar forces of magnitudes 8 N, 12 N and 2 N act at a point. The resultant of the forces has magnitude R N. The directions of the three forces and the resultant are shown in the diagram. Find R and θ. [7]

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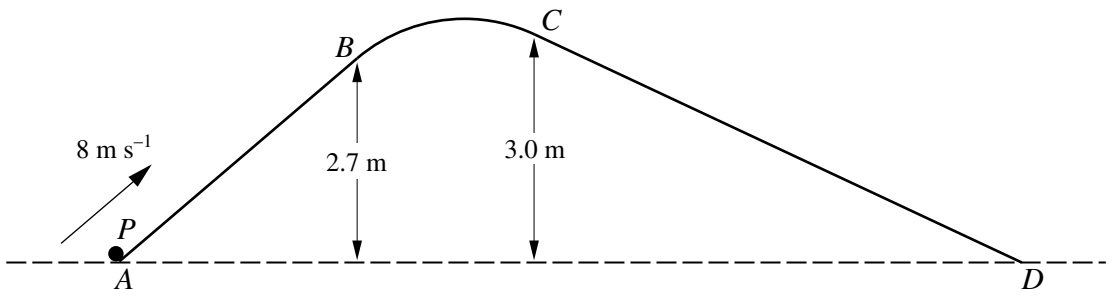
5 Particle P travels along a straight line from A to B with constant acceleration $0.05\,\text{m s}^{-2}$. Its speed at A is $2\,\text{m s}^{-1}$ and its speed at B is $5\,\text{m s}^{-1}$.

(i) Find the time taken for P to travel from A to B, and find also the distance AB. [3]

Particle Q also travels along the same straight line from A to B, starting from rest at A. At time t s after leaving A, the speed of Q is $kt^3\,\text{m s}^{-1}$, where k is a constant. Q takes the same time to travel from A to B as P does.

(ii) Find the value of k and find Q's speed at B. [5]

6



The diagram shows the vertical cross-section $ABCD$ of a surface. BC is a circular arc, and AB and CD are tangents to BC at B and C respectively. A and D are at the same horizontal level, and B and C are at heights 2.7 m and 3.0 m respectively above the level of A and D. A particle P of mass 0.2 kg is given a velocity of $8\,\text{m s}^{-1}$ at A, in the direction of AB (see diagram). The parts of the surface containing AB and BC are smooth.

(i) Find the decrease in the speed of P as P moves along the surface from B to C. [4]

The part of the surface containing CD exerts a constant frictional force on P, as it moves from C to D, and P comes to rest as it reaches D.

(ii) Find the speed of P when it is at the mid-point of CD. [5]

7 A car of mass 1200 kg moves in a straight line along horizontal ground. The resistance to motion of the car is constant and has magnitude 960 N. The car's engine works at a rate of 17 280 W.

(i) Calculate the acceleration of the car at an instant when its speed is $12\,\text{m s}^{-1}$. [3]

The car passes through the points A and B. While the car is moving between A and B it has constant speed $V\,\text{m s}^{-1}$.

(ii) Show that $V = 18$. [2]

At the instant that the car reaches B the engine is switched off and subsequently provides no energy. The car continues along the straight line until it comes to rest at the point C. The time taken for the car to travel from A to C is 52.5 s.

(iii) Find the distance AC. [5]

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