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

MATHEMATICS **9709/43**

Paper 4 Mechanics 1 **(M1)** **May/June 2010**

1 hour 15 minutes

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

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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.

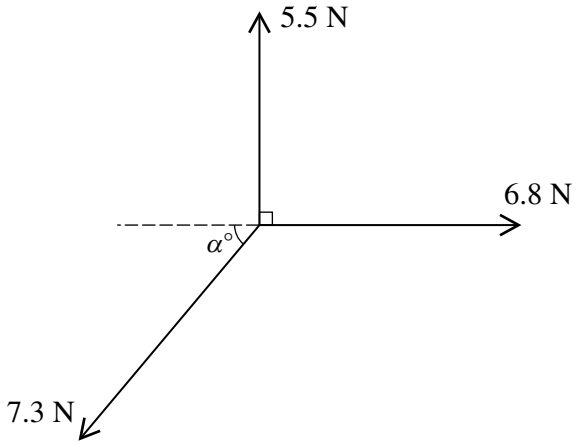
Answer **all** the questions.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
Where a numerical value for the acceleration due to gravity is needed, use $10\,\text{m}\,\text{s}^{-2}$.
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 **4** printed pages.

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1



Three coplanar forces act at a point. The magnitudes of the forces are 5.5 N, 6.8 N and 7.3 N, and the directions in which the forces act are as shown in the diagram. Given that the resultant of the three forces is in the same direction as the force of magnitude 6.8 N, find the value of α and the magnitude of the resultant. [4]

2 A particle starts at a point O and moves along a straight line. Its velocity t s after leaving O is $(1.2t - 0.12t^2)$ m s^{-1}. Find the displacement of the particle from O when its acceleration is 0.6 m s^{-2}. [5]

3 A load is pulled along a horizontal straight track, from A to B, by a force of magnitude P N which acts at an angle of 30° upwards from the horizontal. The distance AB is 80 m. The speed of the load is constant and equal to 1.2 m s^{-1} as it moves from A to the mid-point M of AB.

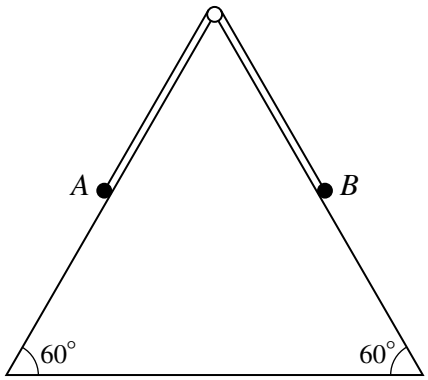
(i) For the motion from A to M the value of P is 25. Calculate the work done by the force as the load moves from A to M. [2]

The speed of the load increases from 1.2 m s^{-1} as it moves from M towards B. For the motion from M to B the value of P is 50 and the work done against resistance is the same as that for the motion from A to M. The mass of the load is 35 kg.

(ii) Find the gain in kinetic energy of the load as it moves from M to B and hence find the speed with which it reaches B. [5]

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4



The diagram shows a vertical cross-section of a triangular prism which is fixed so that two of its faces are inclined at 60° to the horizontal. One of these faces is smooth and one is rough. Particles A and B, of masses 0.36 kg and 0.24 kg respectively, are attached to the ends of a light inextensible string which passes over a small smooth pulley fixed at the highest point of the cross-section. B is held at rest at a point of the cross-section on the rough face and A hangs freely in contact with the smooth face (see diagram). B is released and starts to move up the face with acceleration $0.25\,\text{m s}^{-2}$.

(i) By considering the motion of A, show that the tension in the string is 3.03 N, correct to 3 significant figures. [2]

(ii) Find the coefficient of friction between B and the rough face, correct to 2 significant figures. [6]

5 A ball moves on the horizontal surface of a billiards table with deceleration of constant magnitude $d\,\text{m s}^{-2}$. The ball starts at A with speed $1.4\,\text{m s}^{-1}$ and reaches the edge of the table at B, 1.2 s later, with speed $1.1\,\text{m s}^{-1}$.

(i) Find the distance AB and the value of d. [3]

AB is at right angles to the edge of the table containing B. The table has a low wall along each of its edges and the ball rebounds from the wall at B and moves directly towards A. The ball comes to rest at C where the distance BC is 2 m.

(ii) Find the speed with which the ball starts to move towards A and the time taken for the ball to travel from B to C. [3]

(iii) Sketch a velocity-time graph for the motion of the ball, from the time the ball leaves A until it comes to rest at C, showing on the axes the values of the velocity and the time when the ball is at A, at B and at C. [2]

6 Particles P and Q move on a line of greatest slope of a smooth inclined plane. P is released from rest at a point O on the line and 2 s later passes through the point A with speed $3.5\,\text{m s}^{-1}$.

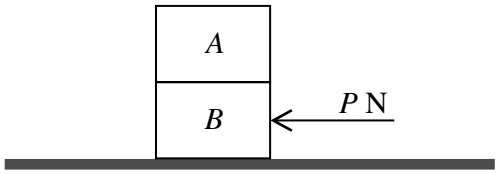
(i) Find the acceleration of P and the angle of inclination of the plane. [4]

At the instant that P passes through A the particle Q is released from rest at O. At time t s after Q is released from O, the particles P and Q are 4.9 m apart.

(ii) Find the value of t. [5]

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7



Two rectangular boxes A and B are of identical size. The boxes are at rest on a rough horizontal floor with A on top of B. Box A has mass 200 kg and box B has mass 250 kg. A horizontal force of magnitude P N is applied to B (see diagram). The boxes remain at rest if $P \leqslant 3150$ and start to move if $P > 3150$.

(i) Find the coefficient of friction between B and the floor. [3]

The coefficient of friction between the two boxes is 0.2. Given that $P > 3150$ and that no sliding takes place between the boxes,

(ii) show that the acceleration of the boxes is not greater than $2\,\text{m}\,\text{s}^{-2}$, [3]

(iii) find the maximum possible value of P. [3]

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