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

MATHEMATICS **9709/42**

Paper 4 Mechanics 1 **(M1)** **May/June 2012**

1 hour 15 minutes

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

* 6 4 1 8 7 5 7 8 0 3 *

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.

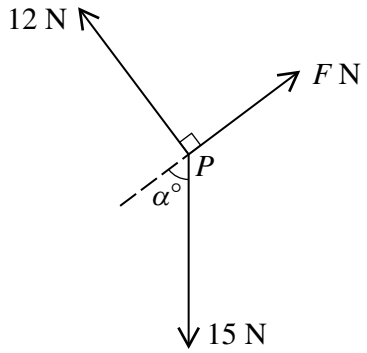
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 50.
Questions carrying smaller numbers of marks are printed earlier in the paper, and questions 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 A block is pulled in a straight line along horizontal ground by a force of constant magnitude acting at an angle of 60° above the horizontal. The work done by the force in moving the block a distance of 5 m is 75 J. Find the magnitude of the force. [3]

2



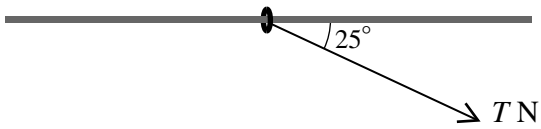
Three coplanar forces of magnitudes F N, 12 N and 15 N are in equilibrium acting at a point P in the directions shown in the diagram. Find α and F. [4]

3 A particle P moves in a straight line, starting from the point O with velocity $2\,\text{m s}^{-1}$. The acceleration of P at time t s after leaving O is $2t^{\frac{2}{3}}\,\text{m s}^{-2}$.

(i) Show that $t^{\frac{5}{3}} = \frac{5}{6}$ when the velocity of P is $3\,\text{m s}^{-1}$. [4]

(ii) Find the distance of P from O when the velocity of P is $3\,\text{m s}^{-1}$. [3]

4



A ring of mass 4 kg is attached to one end of a light string. The ring is threaded on a fixed horizontal rod and the string is pulled at an angle of 25° below the horizontal (see diagram). With a tension in the string of T N the ring is in equilibrium.

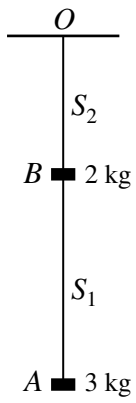
(i) Find, in terms of T, the horizontal and vertical components of the force exerted on the ring by the rod. [4]

The coefficient of friction between the ring and the rod is 0.4.

(ii) Given that the equilibrium is limiting, find the value of T. [3]

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5



A block A of mass 3 kg is attached to one end of a light inextensible string S_1. Another block B of mass 2 kg is attached to the other end of S_1, and is also attached to one end of another light inextensible string S_2. The other end of S_2 is attached to a fixed point O and the blocks hang in equilibrium below O (see diagram).

(i) Find the tension in S_1 and the tension in S_2. [2]

The string S_2 breaks and the particles fall. The air resistance on A is 1.6 N and the air resistance on B is 4 N.

(ii) Find the acceleration of the particles and the tension in S_1. [5]

6 A car of mass 1250 kg travels from the bottom to the top of a straight hill which has length 400 m and is inclined to the horizontal at an angle of α, where $\sin \alpha = 0.125$. The resistance to the car's motion is 800 N. Find the work done by the car's engine in each of the following cases.

(i) The car's speed is constant. [4]

(ii) The car's initial speed is $6\,\text{m s}^{-1}$, the car's driving force is 3 times greater at the top of the hill than it is at the bottom, and the car's power output is 5 times greater at the top of the hill than it is at the bottom. [5]

7



The frictional force acting on a small block of mass 0.15 kg, while it is moving on a horizontal surface, has magnitude 0.12 N. The block is set in motion from a point X on the surface, with speed $3\,\text{m s}^{-1}$. It hits a vertical wall at a point Y on the surface 2 s later. The block rebounds from the wall and moves directly towards X before coming to rest at the point Z (see diagram). At the instant that the block hits the wall it loses 0.072 J of its kinetic energy. The velocity of the block, in the direction from X to Y, is $v\,\text{m s}^{-1}$ at time t s after it leaves X.

(i) Find the values of v when the block arrives at Y and when it leaves Y, and find also the value of t when the block comes to rest at Z. Sketch the velocity-time graph. [9]

(ii) The displacement of the block from X, in the direction from X to Y, is s m at time t s. Sketch the displacement-time graph. Show on your graph the values of s and t when the block is at Y and when it comes to rest at Z. [4]

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