Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

MATHEMATICS **9709/42**

Paper 4 Mechanics 1 **(M1)** **February/March 2016**

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

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.

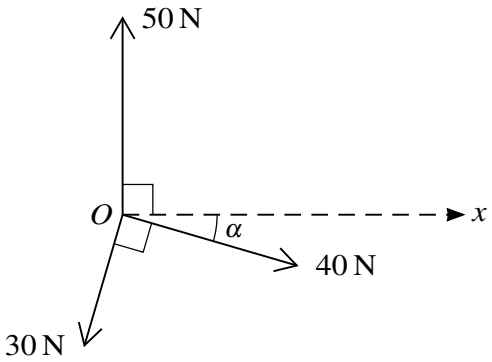
1 A cyclist has mass 85 kg and rides a bicycle of mass 20 kg. The cyclist rides along a horizontal road against a total resistance force of 40 N. Find the total work done by the cyclist in increasing his speed from $5\,\text{m s}^{-1}$ to $10\,\text{m s}^{-1}$ while travelling a distance of 50 m. [3]

2 A constant resistance of magnitude 1350 N acts on a car of mass 1200 kg.

(i) The car is moving along a straight level road at a constant speed of $32\,\text{m s}^{-1}$. Find, in kW, the rate at which the engine of the car is working. [2]

(ii) The car travels at a constant speed up a hill inclined at an angle of θ to the horizontal, where $\sin\theta = 0.1$, with the engine working at 76.5 kW. Find this speed. [3]

3



Coplanar forces of magnitudes 50 N, 40 N and 30 N act at a point O in the directions shown in the diagram, where $\tan\alpha = \frac{7}{24}$.

(i) Find the magnitude and direction of the resultant of the three forces. [6]

(ii) The force of magnitude 50 N is replaced by a force of magnitude P N acting in the same direction. The resultant of the three forces now acts in the positive x-direction. Find the value of P. [1]

4 A particle P of mass 0.8 kg is placed on a rough horizontal table. The coefficient of friction between P and the table is μ. A force of magnitude 5 N, acting upwards at an angle α above the horizontal, where $\tan\alpha = \frac{3}{4}$, is applied to P. The particle is on the point of sliding on the table.

(i) Find the value of μ. [4]

(ii) The magnitude of the force acting on P is increased to 10 N, with the direction of the force remaining the same. Find the acceleration of P. [3]

5 A car of mass 1200 kg is pulling a trailer of mass 800 kg up a hill inclined at an angle α to the horizontal, where $\sin\alpha = 0.1$. The system of the car and the trailer is modelled as two particles connected by a light inextensible cable. The driving force of the car's engine is 2500 N and the resistances to the car and trailer are 100 N and 150 N respectively.

(i) Find the acceleration of the system and the tension in the cable. [4]

(ii) When the car and trailer are travelling at a speed of $30\,\text{m s}^{-1}$, the driving force becomes zero. The cable remains taut. Find the time, in seconds, before the system comes to rest. [3]

6 Two particles A and B, of masses 0.8 kg and 0.2 kg respectively, are connected by a light inextensible string. Particle A is placed on a horizontal surface. The string passes over a small smooth pulley P fixed at the edge of the surface, and B hangs freely. The horizontal section of the string, AP, is of length 2.5 m. The particles are released from rest with both sections of the string taut.

(i) Given that the surface is smooth, find the time taken for A to reach the pulley. [5]

(ii) Given instead that the surface is rough and the coefficient of friction between A and the surface is 0.1, find the speed of A immediately before it reaches the pulley. [5]

7 A particle P moves in a straight line. The velocity v m s^{-1} at time t s is given by

$$\begin{aligned} v &= 5t(t-2) && \text{for } 0 \leqslant t \leqslant 4, \\ v &= k && \text{for } 4 \leqslant t \leqslant 14, \\ v &= 68 - 2t && \text{for } 14 \leqslant t \leqslant 20, \end{aligned}$$

where k is a constant.

(i) Find k. [1]

(ii) Sketch the velocity-time graph for $0 \leqslant t \leqslant 20$. [3]

(iii) Find the set of values of t for which the acceleration of P is positive. [2]

(iv) Find the total distance travelled by P in the interval $0 \leqslant t \leqslant 20$. [5]

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