Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

MATHEMATICS **9709/41**

Paper 4 Mechanics 1 **(M1)** **May/June 2015**

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.

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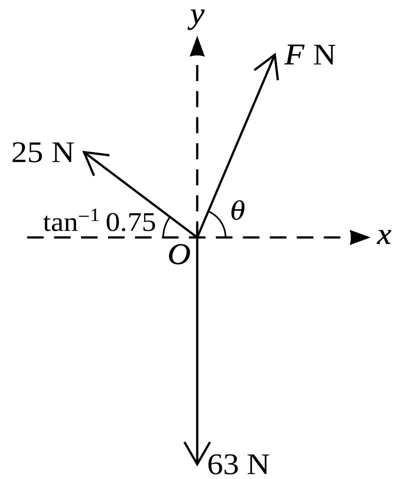
1 A block B of mass 2.7 kg is pulled at constant speed along a straight line on a rough horizontal floor. The pulling force has magnitude 25 N and acts at an angle of θ above the horizontal. The normal component of the contact force acting on B has magnitude 20 N.

(i) Show that $\sin\theta = 0.28$. [2]

(ii) Find the work done by the pulling force in moving the block a distance of 5 m. [2]

2



Three horizontal forces of magnitudes F N, 63 N and 25 N act at O, the origin of the x-axis and y-axis. The forces are in equilibrium. The force of magnitude F N makes an angle θ anticlockwise with the positive x-axis. The force of magnitude 63 N acts along the negative y-axis. The force of magnitude 25 N acts at $\tan^{-1} 0.75$ clockwise from the negative x-axis (see diagram). Find the value of F and the value of $\tan\theta$. [5]

3 A block of weight 6.1 N slides down a slope inclined at $\tan^{-1}\left(\frac{11}{60}\right)$ to the horizontal. The coefficient of friction between the block and the slope is $\frac{1}{4}$. The block passes through a point A with speed $2\,\text{m}\,\text{s}^{-1}$. Find how far the block moves from A before it comes to rest. [5]

4 A lorry of mass 14 000 kg moves along a road starting from rest at a point O. It reaches a point A, and then continues to a point B which it reaches with a speed of $24\,\text{m}\,\text{s}^{-1}$. The part OA of the road is straight and horizontal and has length 400 m. The part AB of the road is straight and is inclined downwards at an angle of $\theta°$ to the horizontal and has length 300 m.

(i) For the motion from O to B, find the gain in kinetic energy of the lorry and express its loss in potential energy in terms of θ. [3]

The resistance to the motion of the lorry is 4800 N and the work done by the driving force of the lorry from O to B is 5000 kJ.

(ii) Find the value of θ. [3]

5 A cyclist and her bicycle have a total mass of 84 kg. She works at a constant rate of P W while moving on a straight road which is inclined to the horizontal at an angle θ, where $\sin\theta = 0.1$. When moving uphill, the cyclist's acceleration is $1.25\,\text{m}\,\text{s}^{-2}$ at an instant when her speed is $3\,\text{m}\,\text{s}^{-1}$. When moving downhill, the cyclist's acceleration is $1.25\,\text{m}\,\text{s}^{-2}$ at an instant when her speed is $10\,\text{m}\,\text{s}^{-1}$. The resistance to the cyclist's motion, whether the cyclist is moving uphill or downhill, is R N. Find the values of P and R. [8]

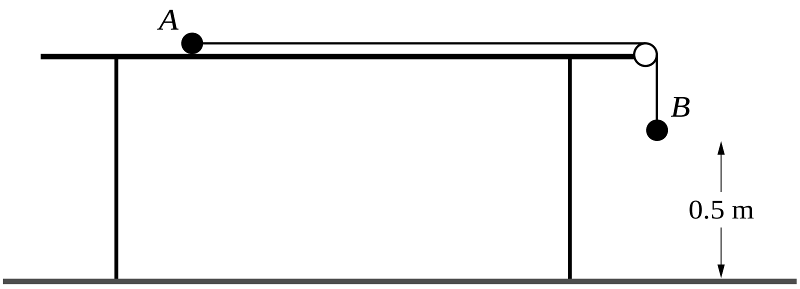
6 Two particles A and B start to move at the same instant from a point O. The particles move in the same direction along the same straight line. The acceleration of A at time t s after starting to move is $a\,\text{m}\,\text{s}^{-2}$, where $a = 0.05 - 0.0002t$.

(i) Find A's velocity when $t = 200$ and when $t = 500$. [4]

B moves with constant acceleration for the first 200 s and has the same velocity as A when $t = 200$. B moves with constant retardation from $t = 200$ to $t = 500$ and has the same velocity as A when $t = 500$.

(ii) Find the distance between A and B when $t = 500$. [6]

7



Particles A and B, of masses 0.3 kg and 0.7 kg respectively, are attached to the ends of a light inextensible string. Particle A is held at rest on a rough horizontal table with the string passing over a smooth pulley fixed at the edge of the table. The coefficient of friction between A and the table is 0.2. Particle B hangs vertically below the pulley at a height of 0.5 m above the floor (see diagram). The system is released from rest and 0.25 s later the string breaks. A does not reach the pulley in the subsequent motion. Find

(i) the speed of B immediately before it hits the floor, [9]

(ii) the total distance travelled by A. [3]

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