Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

MATHEMATICS **9709/41**

Paper 4 Mechanics 1 **(M1)** **October/November 2014**

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.

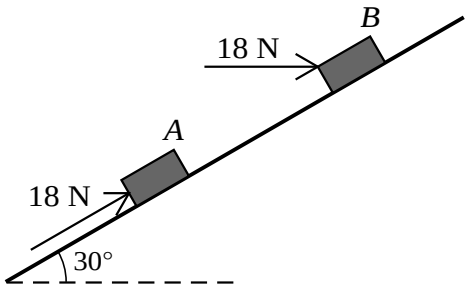
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 50.
Questions carrying smaller numbers of marks are printed earlier in the paper, and questions 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 car of mass 800 kg is moving on a straight horizontal road with its engine working at a rate of 22.5 kW. Find the resistance to the car's motion at an instant when the car's speed is $18\,\text{m s}^{-1}$ and its acceleration is $1.2\,\text{m s}^{-2}$. [4]

2



Small blocks A and B are held at rest on a smooth plane inclined at 30° to the horizontal. Each is held in equilibrium by a force of magnitude 18 N. The force on A acts upwards parallel to a line of greatest slope of the plane, and the force on B acts horizontally in the vertical plane containing a line of greatest slope (see diagram). Find the weight of A and the weight of B. [4]

3

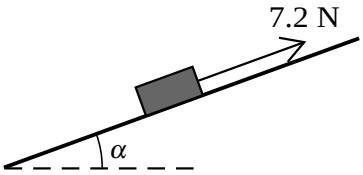


Fig. 1

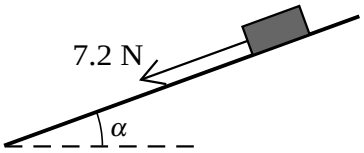


Fig. 2

A block of weight 7.5 N is at rest on a plane which is inclined to the horizontal at angle α, where $\tan\alpha = \frac{7}{24}$. The coefficient of friction between the block and the plane is μ. A force of magnitude 7.2 N acting parallel to a line of greatest slope is applied to the block. When the force acts up the plane (see Fig. 1) the block remains at rest.

(i) Show that $\mu \geqslant \frac{17}{24}$. [4]

When the force acts down the plane (see Fig. 2) the block slides downwards.

(ii) Show that $\mu < \frac{31}{24}$. [2]

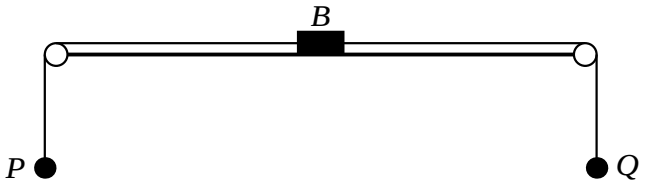
4 Particles P and Q move on a straight line AOB. The particles leave O simultaneously, with P moving towards A and with Q moving towards B. The initial speed of P is $1.3\,\text{m s}^{-1}$ and its acceleration in the direction OA is $0.1\,\text{m s}^{-2}$. Q moves with acceleration in the direction OB of $0.016t\,\text{m s}^{-2}$, where t seconds is the time elapsed since the instant that P and Q started to move from O. When $t = 20$, particle P passes through A and particle Q passes through B.

(i) Given that the speed of Q at B is the same as the speed of P at A, find the speed of Q at time $t = 0$. [4]

(ii) Find the distance AB. [3]

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5



A small block B of mass 0.25 kg is attached to the mid-point of a light inextensible string. Particles P and Q, of masses 0.2 kg and 0.3 kg respectively, are attached to the ends of the string. The string passes over two smooth pulleys fixed at opposite sides of a rough table, with B resting in limiting equilibrium on the table between the pulleys and particles P and Q and block B are in the same vertical plane (see diagram).

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

Q is now removed so that P and B begin to move.

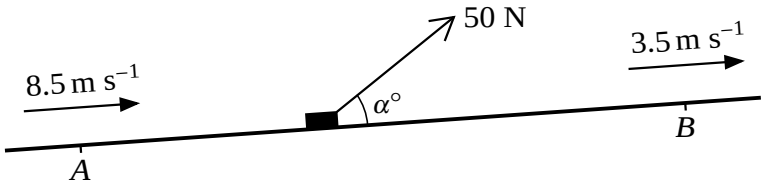
(ii) Find the acceleration of P and the tension in the part PB of the string. [6]

6 A particle of mass 3 kg falls from rest at a point 5 m above the surface of a liquid which is in a container. There is no instantaneous change in speed of the particle as it enters the liquid. The depth of the liquid in the container is 4 m. The downward acceleration of the particle while it is moving in the liquid is $5.5\,\text{m s}^{-2}$.

(i) Find the resistance to motion of the particle while it is moving in the liquid. [2]

(ii) Sketch the velocity-time graph for the motion of the particle, from the time it starts to move until the time it reaches the bottom of the container. Show on your sketch the velocity and the time when the particle enters the liquid, and when the particle reaches the bottom of the container. [7]

7



A block of mass 60 kg is pulled up a hill in the line of greatest slope by a force of magnitude 50 N acting at an angle $\alpha°$ above the hill. The block passes through points A and B with speeds $8.5\,\text{m s}^{-1}$ and $3.5\,\text{m s}^{-1}$ respectively (see diagram). The distance AB is 250 m and B is 17.5 m above the level of A. The resistance to motion of the block is 6 N. Find the value of α. [11]

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