Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

MATHEMATICS **9709/43**

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 **4** printed pages.

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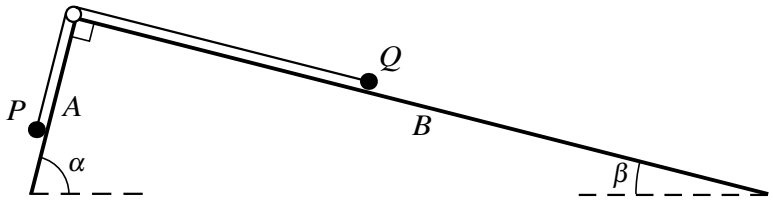
1 A car of mass 1400 kg moves on a horizontal straight road. The resistance to the car's motion is constant and equal to 800 N and the power of the car's engine is constant and equal to P W. At an instant when the car's speed is 18 m s^{-1} its acceleration is 0.5 m s^{-2}.

(i) Find the value of P. [3]

The car continues and passes through another point with speed 25 m s^{-1}.

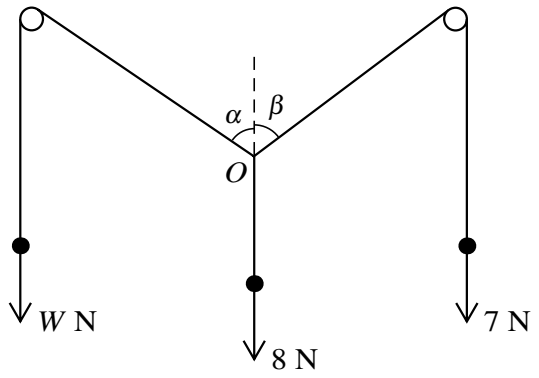
(ii) Find the car's acceleration at this point. [2]

2



The tops of each of two smooth inclined planes A and B meet at a right angle. Plane A is inclined at angle α to the horizontal and plane B is inclined at angle β to the horizontal, where $\sin\alpha = \frac{63}{65}$ and $\sin\beta = \frac{16}{65}$. A small smooth pulley is fixed at the top of the planes and a light inextensible string passes over the pulley. Two particles P and Q, each of mass 0.65 kg, are attached to the string, one at each end. Particle Q is held at rest at a point of the same line of greatest slope of the plane B as the pulley. Particle P rests freely below the pulley in contact with plane A (see diagram). Particle Q is released and the particles start to move with the string taut. Find the tension in the string. [5]

3



Each of three light inextensible strings has a particle attached to one of its ends. The other ends of the strings are tied together at a point O. Two of the strings pass over fixed smooth pegs and the particles hang freely in equilibrium. The weights of the particles and the angles between the sloping parts of the strings and the vertical are as shown in the diagram. It is given that $\sin\beta = 0.8$ and $\cos\beta = 0.6$.

(i) Show that $W\cos\alpha = 3.8$ and find the value of $W\sin\alpha$. [3]

(ii) Hence find the values of W and α. [3]

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4 A particle P starts from rest and moves in a straight line for 18 seconds. For the first 8 seconds of the motion P has constant acceleration $0.25\,\text{m s}^{-2}$. Subsequently P's velocity, $v\,\text{m s}^{-1}$ at time t seconds after the motion started, is given by

$$v = -0.1t^2 + 2.4t - k,$$

where $8 \leqslant t \leqslant 18$ and k is a constant.

(i) Find the value of v when $t = 8$ and hence find the value of k. [2]

(ii) Find the maximum velocity of P. [2]

(iii) Find the displacement of P from its initial position when $t = 18$. [3]

5 A box of mass 8 kg is on a rough plane inclined at 5° to the horizontal. A force of magnitude P N acts on the box in a direction upwards and parallel to a line of greatest slope of the plane. When $P = 7X$ the box moves up the line of greatest slope with acceleration $0.15\,\text{m s}^{-2}$ and when $P = 8X$ the box moves up the line of greatest slope with acceleration $1.15\,\text{m s}^{-2}$. Find the value of X and the coefficient of friction between the box and the plane. [8]

6

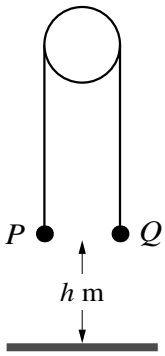


Fig. 1

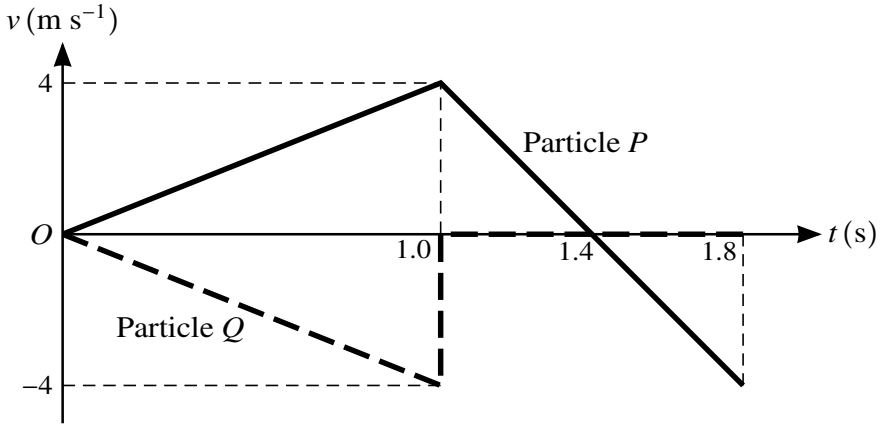


Fig. 2

Particles P and Q have a total mass of 1 kg. The particles are attached to opposite ends of a light inextensible string which passes over a smooth fixed pulley. P is held at rest and Q hangs freely, with both straight parts of the string vertical. Both particles are at a height of h m above the floor (see Fig. 1). P is released from rest and the particles start to move with the string taut. Fig. 2 shows the velocity-time graphs for P's motion and for Q's motion, where the positive direction for velocity is vertically upwards. Find

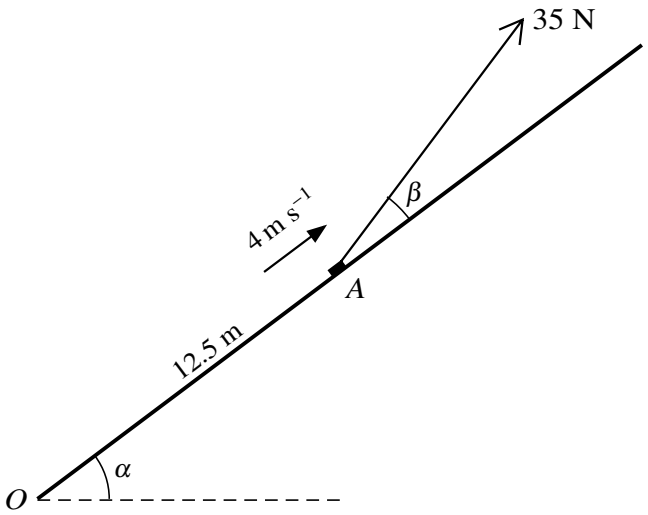
(i) the magnitude of the acceleration with which the particles start to move and the mass of each of the particles, [5]

(ii) the value of h, [1]

(iii) the greatest height above the floor reached by particle P. [2]

[Question 7 is printed on the next page.]

7



A small block of mass 3 kg is initially at rest at the bottom O of a rough plane inclined at an angle α to the horizontal, where $\sin\alpha = 0.6$ and $\cos\alpha = 0.8$. A force of magnitude 35 N acts on the block at an angle β above the plane, where $\sin\beta = 0.28$ and $\cos\beta = 0.96$. The block starts to move up a line of greatest slope of the plane and passes through a point A with speed $4\,\text{m s}^{-1}$. The distance OA is 12.5 m (see diagram).

(i) For the motion of the block from O to A, find the work done against the frictional force acting on the block. [4]

(ii) Find the coefficient of friction between the block and the plane. [3]

At the instant that the block passes through A the force of magnitude 35 N ceases to act.

(iii) Find the distance the block travels up the plane after passing through A. [4]

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