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

MATHEMATICS **9709/43**

Paper 4 Mechanics 1 **(M1)** **May/June 2011**

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 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.

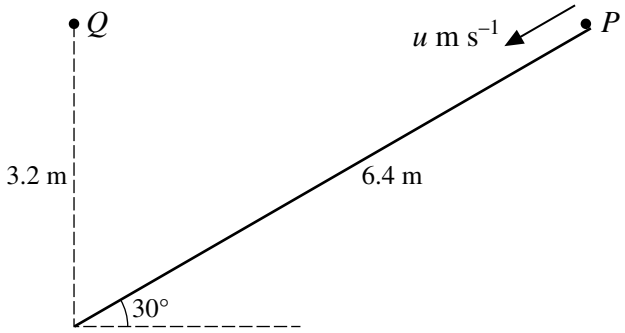
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 50.
Questions carrying smaller numbers of marks are printed earlier in the paper, and questions carrying larger numbers of marks later in the paper.

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1 A block is pulled for a distance of 50 m along a horizontal floor, by a rope that is inclined at an angle of α° to the floor. The tension in the rope is 180 N and the work done by the tension is 8200 J. Find the value of α. [3]

2 A car of mass 1250 kg is travelling along a straight horizontal road with its engine working at a constant rate of P W. The resistance to the car's motion is constant and equal to R N. When the speed of the car is 19 m s^{-1} its acceleration is 0.6 m s^{-2}, and when the speed of the car is 30 m s^{-1} its acceleration is 0.16 m s^{-2}. Find the values of P and R. [6]

3



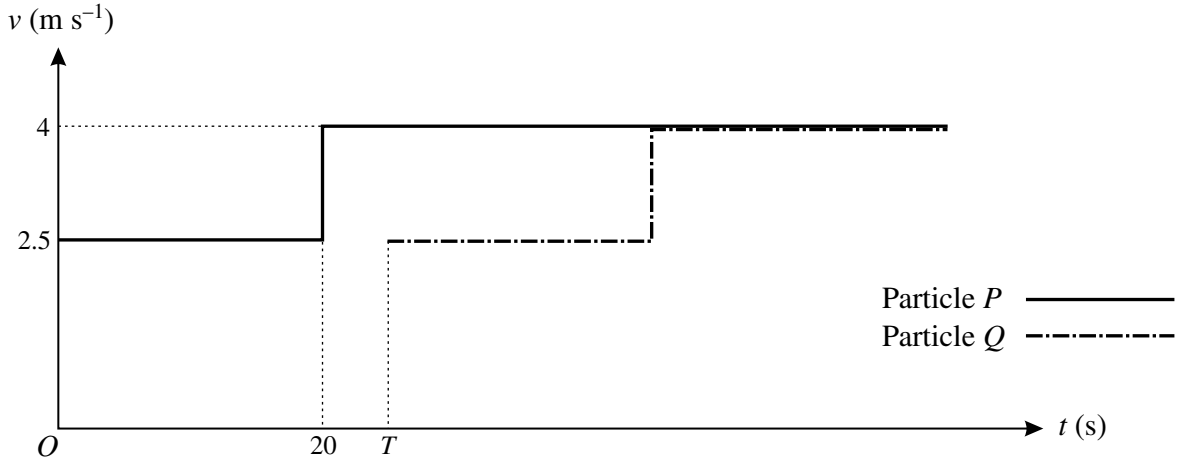
A particle P is projected from the top of a smooth ramp with speed u m s^{-1}, and travels down a line of greatest slope. The ramp has length 6.4 m and is inclined at 30° to the horizontal. Another particle Q is released from rest at a point 3.2 m vertically above the bottom of the ramp, at the same instant that P is projected (see diagram). Given that P and Q reach the bottom of the ramp simultaneously, find

(i) the value of u, [4]

(ii) the speed with which P reaches the bottom of the ramp. [2]

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4



The diagram shows the velocity-time graphs for the motion of two particles P and Q, which travel in the same direction along a straight line. P and Q both start at the same point X on the line, but Q starts to move T s later than P. Each particle moves with speed $2.5\,\text{m s}^{-1}$ for the first 20 s of its motion. The speed of each particle changes instantaneously to $4\,\text{m s}^{-1}$ after it has been moving for 20 s and the particle continues at this speed.

(i) Make a rough copy of the diagram and shade the region whose area represents the displacement of P from X at the instant when Q starts. [1]

It is given that P has travelled 70 m at the instant when Q starts.

(ii) Find the value of T. [2]

(iii) Find the distance between P and Q when Q's speed reaches $4\,\text{m s}^{-1}$. [2]

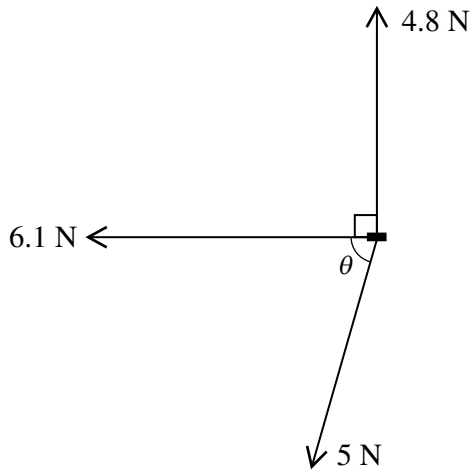
(iv) Sketch a single diagram showing the displacement-time graphs for both P and Q, with values shown on the t-axis at which the speed of either particle changes. [2]

[Questions 5, 6 and 7 are printed on the next page.]

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[Turn over

5



A small block of mass 1.25 kg is on a horizontal surface. Three horizontal forces, with magnitudes and directions as shown in the diagram, are applied to the block. The angle θ is such that $\cos\theta = 0.28$ and $\sin\theta = 0.96$. A horizontal frictional force also acts on the block, and the block is in equilibrium.

(i) Show that the magnitude of the frictional force is 7.5 N and state the direction of this force. [4]

(ii) Given that the block is in limiting equilibrium, find the coefficient of friction between the block and the surface. [2]

The force of magnitude 6.1 N is now replaced by a force of magnitude 8.6 N acting in the same direction, and the block begins to move.

(iii) Find the magnitude and direction of the acceleration of the block. [3]

6 A lorry of mass 15 000 kg climbs a hill of length 500 m at a constant speed. The hill is inclined at 2.5° to the horizontal. The resistance to the lorry's motion is constant and equal to 800 N.

(i) Find the work done by the lorry's driving force. [4]

On its return journey the lorry reaches the top of the hill with speed $20\,\text{m s}^{-1}$ and continues down the hill with a constant driving force of 2000 N. The resistance to the lorry's motion is again constant and equal to 800 N.

(ii) Find the speed of the lorry when it reaches the bottom of the hill. [5]

7 A particle travels in a straight line from A to B in 20 s. Its acceleration t seconds after leaving A is $a\,\text{m s}^{-2}$, where $a = \frac{3}{160}t^2 - \frac{1}{800}t^3$. It is given that the particle comes to rest at B.

(i) Show that the initial speed of the particle is zero. [4]

(ii) Find the maximum speed of the particle. [2]

(iii) Find the distance AB. [4]

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