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

MATHEMATICS **9709/41**

Paper 4 Mechanics 1 **(M1)** **October/November 2010**

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.

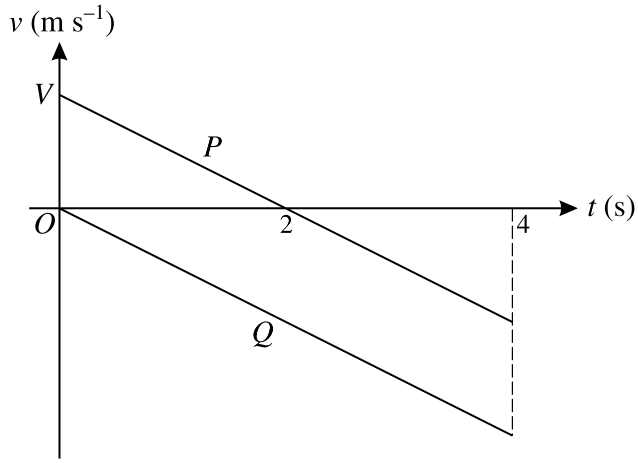
Answer **all** the questions.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
Where a numerical value for the acceleration due to gravity is needed, use $10\,\mathrm{m\,s^{-2}}$.
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.

UNIVERSITY of CAMBRIDGE International Examinations

1



Two particles P and Q move vertically under gravity. The graphs show the upward velocity v m s^{-1} of the particles at time t s, for $0 \leqslant t \leqslant 4$. P starts with velocity V m s^{-1} and Q starts from rest.

(i) Find the value of V. [2]

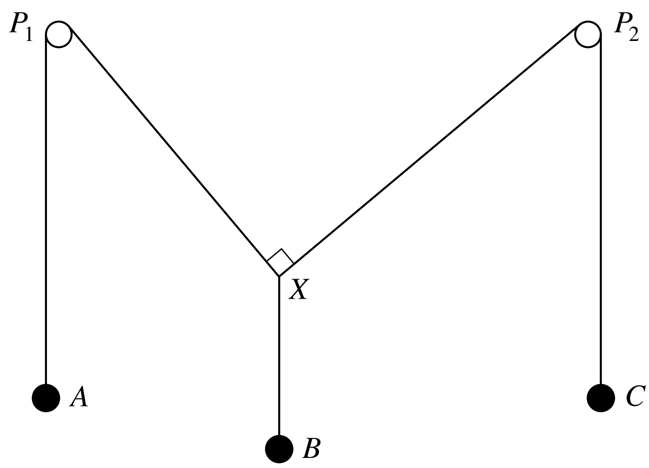
Given that Q reaches the horizontal ground when $t = 4$, find

(ii) the speed with which Q reaches the ground, [1]

(iii) the height of Q above the ground when $t = 0$. [2]

2 A car of mass 600 kg travels along a horizontal straight road, with its engine working at a rate of 40 kW. The resistance to motion of the car is constant and equal to 800 N. The car passes through the point A on the road with speed 25 m s^{-1}. The car's acceleration at the point B on the road is half its acceleration at A. Find the speed of the car at B. [5]

3



The diagram shows three particles A, B and C hanging freely in equilibrium, each being attached to the end of a string. The other ends of the three strings are tied together and are at the point X. The strings carrying A and C pass over smooth fixed horizontal pegs P_1 and P_2 respectively. The weights of A, B and C are 5.5 N, 7.3 N and W N respectively, and the angle P_1XP_2 is a right angle. Find the angle AP_1X and the value of W. [5]

4 A particle P starts from a fixed point O at time $t = 0$, where t is in seconds, and moves with constant acceleration in a straight line. The initial velocity of P is $1.5\,\text{m s}^{-1}$ and its velocity when $t = 10$ is $3.5\,\text{m s}^{-1}$.

(i) Find the displacement of P from O when $t = 10$. [2]

Another particle Q also starts from O when $t = 0$ and moves along the same straight line as P. The acceleration of Q at time t is $0.03t\,\text{m s}^{-2}$.

(ii) Given that Q has the same velocity as P when $t = 10$, show that it also has the same displacement from O as P when $t = 10$. [5]

5 A particle of mass 0.8 kg slides down a rough inclined plane along a line of greatest slope AB. The distance AB is 8 m. The particle starts at A with speed $3\,\text{m s}^{-1}$ and moves with constant acceleration $2.5\,\text{m s}^{-2}$.

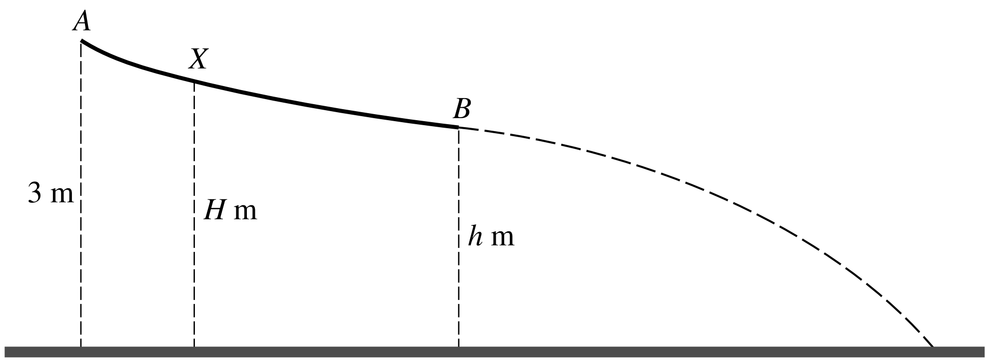
(i) Find the speed of the particle at the instant it reaches B. [2]

(ii) Given that the work done against the frictional force as the particle moves from A to B is 7 J, find the angle of inclination of the plane. [4]

When the particle is at the point X its speed is the same as the average speed for the motion from A to B.

(iii) Find the work done by the frictional force for the particle's motion from A to X. [3]

6



A smooth slide AB is fixed so that its highest point A is 3 m above horizontal ground. B is h m above the ground. A particle P of mass 0.2 kg is released from rest at a point on the slide. The particle moves down the slide and, after passing B, continues moving until it hits the ground (see diagram). The speed of P at B is v_B and the speed at which P hits the ground is v_G.

(i) In the case that P is released at A, it is given that the kinetic energy of P at B is 1.6 J. Find

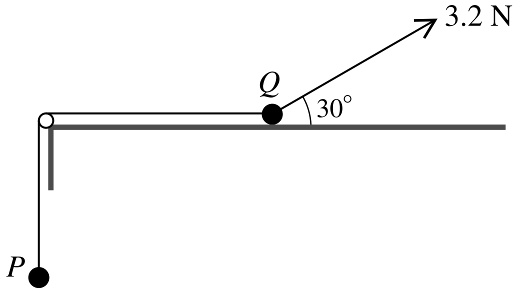
(a) the value of h, [3]

(b) the kinetic energy of the particle immediately before it reaches the ground, [1]

(c) the ratio $v_G : v_B$. [2]

(ii) In the case that P is released at the point X of the slide, which is H m above the ground (see diagram), it is given that $v_G : v_B = 2.55$. Find the value of H correct to 2 significant figures. [3]

7



Particles P and Q, of masses 0.2 kg and 0.5 kg respectively, are connected by a light inextensible string. The string passes over a smooth pulley at the edge of a rough horizontal table. P hangs freely and Q is in contact with the table. A force of magnitude 3.2 N acts on Q, upwards and away from the pulley, at an angle of $30°$ to the horizontal (see diagram).

(i) The system is in limiting equilibrium with P about to move upwards. Find the coefficient of friction between Q and the table. [6]

The force of magnitude 3.2 N is now removed and P starts to move downwards.

(ii) Find the acceleration of the particles and the tension in the string. [4]