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

MATHEMATICS **9709/42**

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

1 hour 15 minutes

Additional Materials: Answer Booklet/Paper
Graph Paper
List of Formulae (MF9)

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.

1 A load is pulled along horizontal ground for a distance of 76 m, using a rope. The rope is inclined at 5° above the horizontal and the tension in the rope is 65 N.

(i) Find the work done by the tension. [2]

At an instant during the motion the velocity of the load is $1.5\,\text{m s}^{-1}$.

(ii) Find the rate of working of the tension at this instant. [2]

2 An object of mass 8 kg slides down a line of greatest slope of an inclined plane. Its initial speed at the top of the plane is $3\,\text{m s}^{-1}$ and its speed at the bottom of the plane is $8\,\text{m s}^{-1}$. The work done against the resistance to motion of the object is 120 J. Find the height of the top of the plane above the level of the bottom. [4]

3

The velocity-time graph shown models the motion of a parachutist falling vertically. There are four stages in the motion:

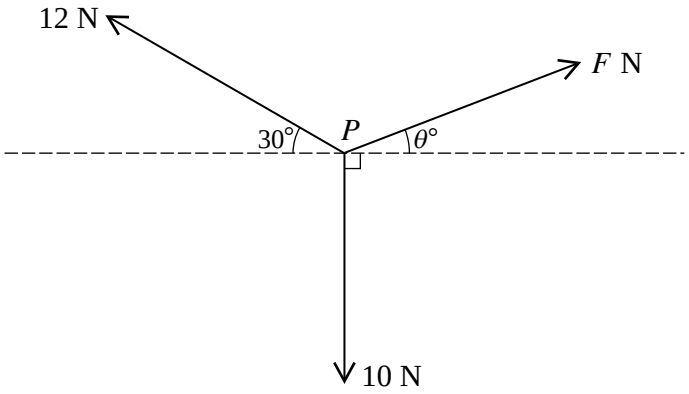
- falling freely with the parachute closed,
- decelerating at a constant rate with the parachute open,
- falling with constant speed with the parachute open,
- coming to rest instantaneously on hitting the ground.

(i) Show that the total distance fallen is 1048 m. [2]

The weight of the parachutist is 850 N.

(ii) Find the upward force on the parachutist due to the parachute, during the second stage. [5]

4



The three coplanar forces shown in the diagram act at a point P and are in equilibrium.

(i) Find the values of F and θ. [6]

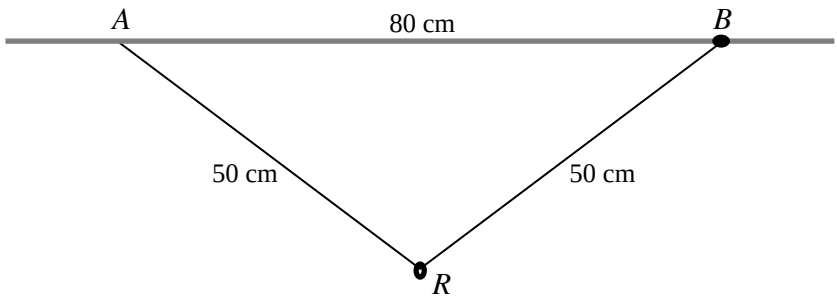
(ii) State the magnitude and direction of the resultant force at P when the force of magnitude 12 N is removed. [2]

5 Two particles P and Q are projected vertically upwards from horizontal ground at the same instant. The speeds of projection of P and Q are $12\,\text{m s}^{-1}$ and $7\,\text{m s}^{-1}$ respectively and the heights of P and Q above the ground, t seconds after projection, are h_P m and h_Q m respectively. Each particle comes to rest on returning to the ground.

(i) Find the set of values of t for which the particles are travelling in opposite directions. [3]

(ii) At a certain instant, P and Q are above the ground and $3h_P = 8h_Q$. Find the velocities of P and Q at this instant. [5]

6



A small smooth ring R, of mass 0.6 kg, is threaded on a light inextensible string of length 100 cm. One end of the string is attached to a fixed point A. A small bead B of mass 0.4 kg is attached to the other end of the string, and is threaded on a fixed rough horizontal rod which passes through A. The system is in equilibrium with B at a distance of 80 cm from A (see diagram).

(i) Find the tension in the string. [3]

(ii) Find the frictional and normal components of the contact force acting on B. [4]

(iii) Given that the equilibrium is limiting, find the coefficient of friction between the bead and the rod. [2]

7 A walker travels along a straight road passing through the points A and B on the road with speeds $0.9\,\text{m s}^{-1}$ and $1.3\,\text{m s}^{-1}$ respectively. The walker's acceleration between A and B is constant and equal to $0.004\,\text{m s}^{-2}$.

(i) Find the time taken by the walker to travel from A to B, and find the distance AB. [3]

A cyclist leaves A at the same instant as the walker. She starts from rest and travels along the straight road, passing through B at the same instant as the walker. At time t s after leaving A the cyclist's speed is $kt^3\,\text{m s}^{-1}$, where k is a constant.

(ii) Show that when $t = 64.05$ the speed of the walker and the speed of the cyclist are the same, correct to 3 significant figures. [5]

(ii) Find the cyclist's acceleration at the instant she passes through B. [2]