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 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.

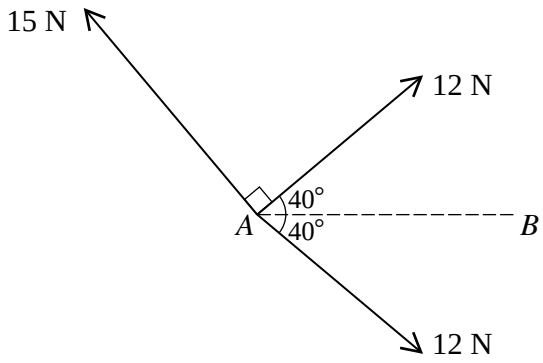
Answer **all** the questions.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
Where a numerical value for the acceleration due to gravity is needed, use $10\,\text{m}\,\text{s}^{-2}$.
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 One end of a light inextensible string is attached to a block. The string is used to pull the block along a horizontal surface with a speed of $2\,\text{m s}^{-1}$. The string makes an angle of 20° with the horizontal and the tension in the string is 25 N. Find the work done by the tension in a period of 8 seconds. [3]

2 Particles A of mass 0.65 kg and B of mass 0.35 kg are attached to the ends of a light inextensible string which passes over a fixed smooth pulley. B is held at rest with the string taut and both of its straight parts vertical. The system is released from rest and the particles move vertically. Find the tension in the string and the magnitude of the resultant force exerted on the pulley by the string. [5]

3



Three coplanar forces of magnitudes 15 N, 12 N and 12 N act at a point A in directions as shown in the diagram.

(i) Find the component of the resultant of the three forces

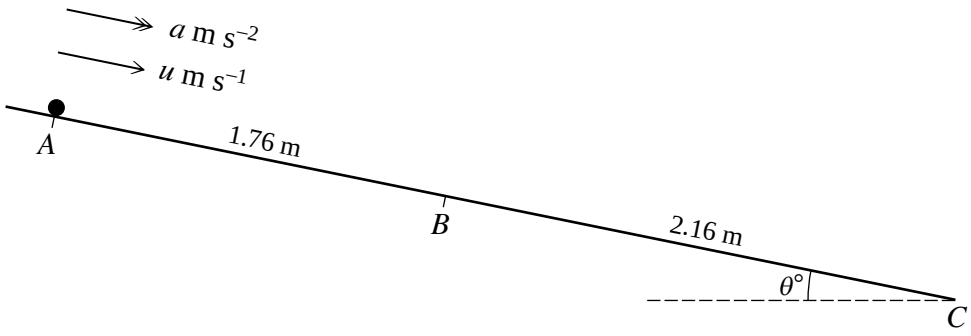
(a) in the direction of AB,

(b) perpendicular to AB.

[3]

(ii) Hence find the magnitude and direction of the resultant of the three forces. [3]

4



A, B and C are three points on a line of greatest slope of a smooth plane inclined at an angle of θ° to the horizontal. A is higher than B and B is higher than C, and the distances AB and BC are 1.76 m and 2.16 m respectively. A particle slides down the plane with constant acceleration $a\,\text{m s}^{-2}$. The speed of the particle at A is $u\,\text{m s}^{-1}$ (see diagram). The particle takes 0.8 s to travel from A to B and takes 1.4 s to travel from A to C. Find

(i) the values of u and a, [6]

(ii) the value of θ. [2]

5

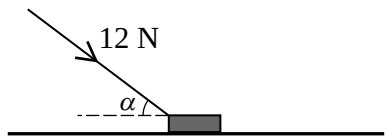


Fig. 1

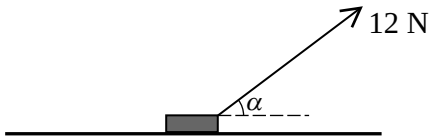


Fig. 2

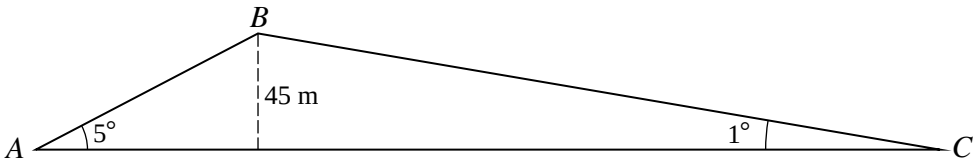
A block of mass 2 kg is at rest on a horizontal floor. The coefficient of friction between the block and the floor is μ. A force of magnitude 12 N acts on the block at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$. When the applied force acts downwards as in Fig. 1 the block remains at rest.

(i) Show that $\mu \geqslant \frac{6}{17}$. [5]

When the applied force acts upwards as in Fig. 2 the block slides along the floor.

(ii) Find another inequality for μ. [3]

6



AB and *BC* are straight roads inclined at 5° to the horizontal and 1° to the horizontal respectively. *A* and *C* are at the same horizontal level and *B* is 45 m above the level of *A* and *C* (see diagram, which is not to scale). A car of mass 1200 kg travels from *A* to *C* passing through *B*.

(i) For the motion from *A* to *B*, the speed of the car is constant and the work done against the resistance to motion is 360 kJ. Find the work done by the car's engine from *A* to *B*. [3]

The resistance to motion is constant throughout the whole journey.

(ii) For the motion from *B* to *C* the work done by the driving force is 1660 kJ. Given that the speed of the car at *B* is 15 m s^{-1}, show that its speed at *C* is 29.9 m s^{-1}, correct to 3 significant figures. [4]

(iii) The car's driving force immediately after leaving *B* is 1.5 times the driving force immediately before reaching *C*. Find, correct to 2 significant figures, the ratio of the power developed by the car's engine immediately after leaving *B* to the power developed immediately before reaching *C*. [3]

[Question 7 is printed on the next page.]

7 A particle P starts from a point O and moves along a straight line. P's velocity t s after leaving O is v m s^{-1}, where

$$v = 0.16t^{\frac{3}{2}} - 0.016t^2.$$

P comes to rest instantaneously at the point A.

(i) Verify that the value of t when P is at A is 100. [1]

(ii) Find the maximum speed of P in the interval $0 < t < 100$. [4]

(iii) Find the distance OA. [3]

(iv) Find the value of t when P passes through O on returning from A. [2]