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

MATHEMATICS **9709/04**

Paper 4 Mechanics 1 **(M1)**

October/November 2003

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 on both sides of the paper.
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 $10\,\text{m}\,\text{s}^{-2}$.
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.
The use of an electronic calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

This document consists of **4** printed pages.

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Local Examinations Syndicate

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1   A motorcycle of mass $100\,\text{kg}$ is travelling on a horizontal straight road. Its engine is working at a rate of $8\,\text{kW}$. At an instant when the speed of the motorcycle is $25\,\text{m s}^{-1}$ its acceleration is $0.5\,\text{m s}^{-2}$. Find, at this instant,

   (i) the force produced by the engine,   [1]

   (ii) the resistance to motion of the motorcycle.   [3]

2   A stone is released from rest and falls freely under gravity. Find

   (i) the speed of the stone after $2\,\text{s}$,   [1]

   (ii) the time taken for the stone to fall a distance of $45\,\text{m}$ from its initial position,   [2]

   (iii) the distance fallen by the stone from the instant when its speed is $30\,\text{m s}^{-1}$ to the instant when its speed is $40\,\text{m s}^{-1}$.   [2]

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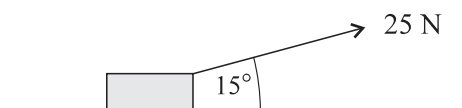
A crate of mass $3\,\text{kg}$ is pulled at constant speed along a horizontal floor. The pulling force has magnitude $25\,\text{N}$ and acts at an angle of $15°$ to the horizontal, as shown in the diagram. Find

   (i) the work done by the pulling force in moving the crate a distance of $2\,\text{m}$,   [2]

   **(ii)** the normal component of the contact force on the crate.   [3]

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The diagram shows a vertical cross-section of a surface. A and B are two points on the cross-section. A particle of mass $0.15\,\text{kg}$ is released from rest at A.

   (i) Assuming that the particle reaches B with a speed of $8\,\text{m s}^{-1}$ and that there are no resistances to motion, find the height of A above B.   [3]

   (ii) Assuming instead that the particle reaches B with a speed of $6\,\text{m s}^{-1}$ and that the height of A above B is $4\,\text{m}$, find the work done against the resistances to motion.   [3]

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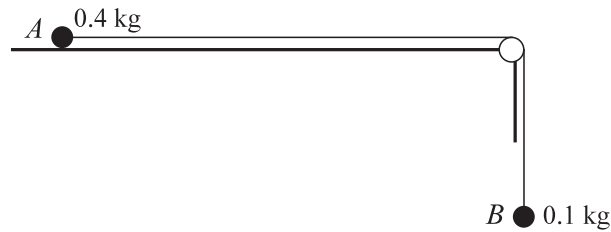
Particles *A* and *B*, of masses 0.4 kg and 0.1 kg respectively, are attached to the ends of a light inextensible string. Particle *A* is held at rest on a horizontal table with the string passing over a smooth pulley at the edge of the table. Particle *B* hangs vertically below the pulley (see diagram). The system is released from rest. In the subsequent motion a constant frictional force of magnitude 0.6 N acts on *A*. Find

  (i) the tension in the string, [4]

  (ii) the speed of *B* 1.5 s after it starts to move. [3]

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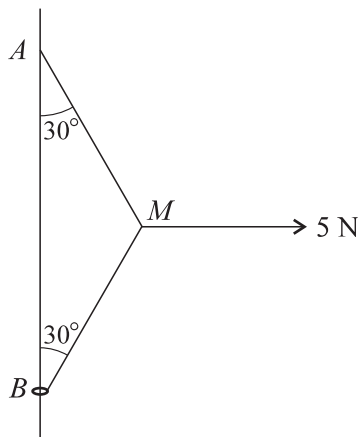
One end of a light inextensible string is attached to a fixed point *A* of a fixed vertical wire. The other end of the string is attached to a small ring *B*, of mass 0.2 kg, through which the wire passes. A horizontal force of magnitude 5 N is applied to the mid-point *M* of the string. The system is in equilibrium with the string taut, with *B* below *A*, and with angles *ABM* and *BAM* equal to 30° (see diagram).

  (i) Show that the tension in *BM* is 5 N. [3]

  (ii) The ring is on the point of sliding up the wire. Find the coefficient of friction between the ring and the wire. [5]

  (iii) A particle of mass *m* kg is attached to the ring. The ring is now on the point of sliding down the wire. Given that the coefficient of friction between the ring and the wire is unchanged, find the value of *m*. [2]

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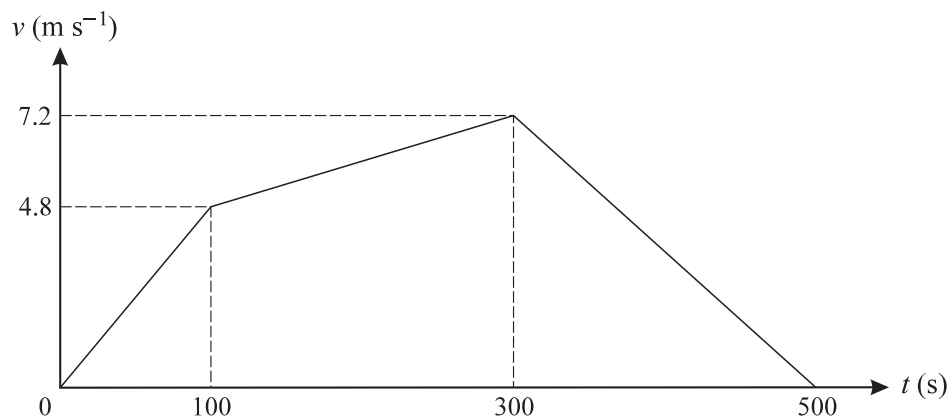
A tractor *A* starts from rest and travels along a straight road for 500 seconds. The velocity-time graph for the journey is shown above. This graph consists of three straight line segments. Find

  (i) the distance travelled by *A*, [3]

 (ii) the initial acceleration of *A*. [2]

Another tractor *B* starts from rest at the same instant as *A*, and travels along the same road for 500 seconds. Its velocity *t* seconds after starting is $(0.06t - 0.00012t^2)$ m s^{-1}. Find

(iii) how much greater *B*'s initial acceleration is than *A*'s, [2]

(iv) how much further *B* has travelled than *A*, at the instant when *B*'s velocity reaches its maximum. [6]