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

**MATHEMATICS** **9709/41**

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

**1 hour 15 minutes**

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

*3847556196*

**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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**[Turn over**

**1** A car of mass 700 kg is travelling along a straight horizontal road. The resistance to motion is constant and equal to 600 N.

**(i)** Find the driving force of the car's engine at an instant when the acceleration is $2\,\text{m s}^{-2}$. [2]

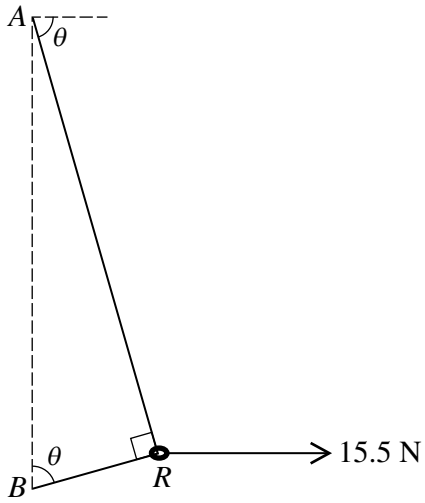
**(ii)** Given that the car's speed at this instant is $15\,\text{m s}^{-1}$, find the rate at which the car's engine is working. [2]

**2** A load of mass 1250 kg is raised by a crane from rest on horizontal ground, to rest at a height of 1.54 m above the ground. The work done against the resistance to motion is 5750 J.

**(i)** Find the work done by the crane. [3]

**(ii)** Assuming the power output of the crane is constant and equal to 1.25 kW, find the time taken to raise the load. [2]

**3**




A small smooth ring $R$ of weight 8.5 N is threaded on a light inextensible string. The ends of the string are attached to fixed points $A$ and $B$, with $A$ vertically above $B$. A horizontal force of magnitude 15.5 N acts on $R$ so that the ring is in equilibrium with angle $ARB = 90^\circ$. The part $AR$ of the string makes an angle $\theta$ with the horizontal and the part $BR$ makes an angle $\theta$ with the vertical (see diagram). The tension in the string is $T$ N. Show that $T \sin\theta = 12$ and $T \cos\theta = 3.5$ and hence find $\theta$. [6]

**4** A block of mass 11 kg is at rest on a rough plane inclined at $30^\circ$ to the horizontal. A force acts on the block in a direction up the plane parallel to a line of greatest slope. When the magnitude of the force is $2X$ N the block is on the point of sliding down the plane, and when the magnitude of the force is $9X$ N the block is on the point of sliding up the plane. Find

**(i)** the value of $X$, [3]

**(ii)** the coefficient of friction between the block and the plane. [4]

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**5** A train starts from rest at a station $A$ and travels in a straight line to station $B$, where it comes to rest. The train moves with constant acceleration $0.025\,\text{m s}^{-2}$ for the first 600 s, with constant speed for the next 2600 s, and finally with constant deceleration $0.0375\,\text{m s}^{-2}$.

**(i)** Find the total time taken for the train to travel from $A$ to $B$. [4]

**(ii)** Sketch the velocity-time graph for the journey and find the distance $AB$. [3]

**(iii)** The speed of the train $t$ seconds after leaving $A$ is $7.5\,\text{m s}^{-1}$. State the possible values of $t$. [1]

**6** A particle travels in a straight line from a point $P$ to a point $Q$. Its velocity $t$ seconds after leaving $P$ is $v\,\text{m s}^{-1}$, where $v = 4t - \frac{1}{16}t^3$. The distance $PQ$ is 64 m.

**(i)** Find the time taken for the particle to travel from $P$ to $Q$. [5]

**(ii)** Find the set of values of $t$ for which the acceleration of the particle is positive. [4]

**7** Loads $A$ and $B$, of masses 1.2 kg and 2.0 kg respectively, are attached to the ends of a light inextensible string which passes over a fixed smooth pulley. $A$ is held at rest and $B$ hangs freely, with both straight parts of the string vertical. $A$ is released and starts to move upwards. It does not reach the pulley in the subsequent motion.

**(i)** Find the acceleration of $A$ and the tension in the string. [4]

**(ii)** Find, for the first 1.5 metres of $A$'s motion,

**(a)** $A$'s gain in potential energy,

**(b)** the work done on $A$ by the tension in the string,

**(c)** $A$'s gain in kinetic energy.

[3]

$B$ hits the floor 1.6 seconds after $A$ is released. $B$ comes to rest without rebounding and the string becomes slack.

**(iii)** Find the time from the instant the string becomes slack until it becomes taut again. [4]

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