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

MATHEMATICS **9709/04**

Paper 4 Mechanics 1 **(M1)** **October/November 2008**

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 $10\,\mathrm{m\,s^{-2}}$.

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.

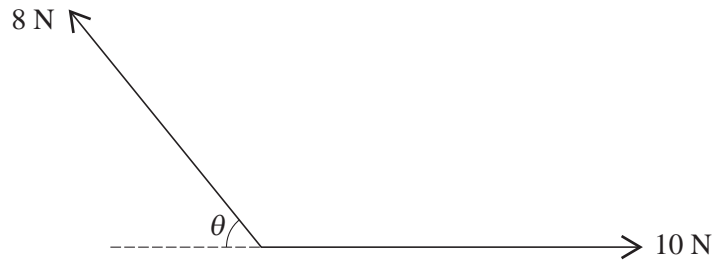The total number of marks for this paper is 50.

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 **3** printed pages and **1** blank page.

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1

Forces of magnitudes 10 N and 8 N act in directions as shown in the diagram.

  (i) Write down in terms of θ the component of the resultant of the two forces

     (a) parallel to the force of magnitude 10 N,   [1]

     (b) perpendicular to the force of magnitude 10 N.   [1]

  (ii) The resultant of the two forces has magnitude 8 N. Show that $\cos\theta = \frac{5}{8}$.   [3]

2   A block of mass 20 kg is at rest on a plane inclined at $10°$ to the horizontal. A force acts on the block parallel to a line of greatest slope of the plane. The coefficient of friction between the block and the plane is 0.32. Find the least magnitude of the force necessary to move the block,

  (i) given that the force acts up the plane,

  (ii) given instead that the force acts down the plane.

                                                       [6]

3   A car of mass 1200 kg is travelling on a horizontal straight road and passes through a point A with speed $25\,\text{m s}^{-1}$. The power of the car's engine is 18 kW and the resistance to the car's motion is 900 N.

  (i) Find the deceleration of the car at A.   [4]

  (ii) Show that the speed of the car does not fall below $20\,\text{m s}^{-1}$ while the car continues to move with the engine exerting a constant power of 18 kW.   [2]

4   A load of mass 160 kg is lifted vertically by a crane, with constant acceleration. The load starts from rest at the point O. After 7 s, it passes through the point A with speed $0.5\,\text{m s}^{-1}$. By considering energy, find the work done by the crane in moving the load from O to A.   [6]

5
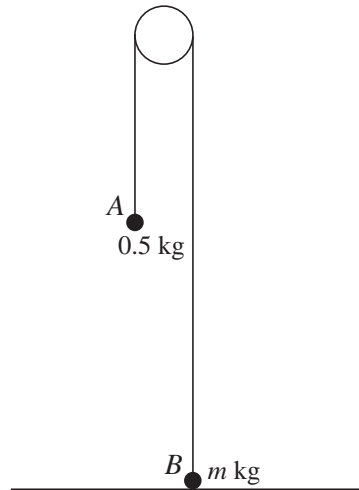
Particles A and B, of masses 0.5 kg and m kg respectively, are attached to the ends of a light inextensible string which passes over a smooth fixed pulley. Particle B is held at rest on the horizontal floor and particle A hangs in equilibrium (see diagram). B is released and each particle starts to move vertically. A hits the floor 2 s after B is released. The speed of each particle when A hits the floor is 5 m s^{-1}.

(i) For the motion while A is moving downwards, find

    (a) the acceleration of A,   [2]

    (b) the tension in the string.   [3]

(ii) Find the value of m.   [3]

6 A train travels from A to B, a distance of 20 000 m, taking 1000 s. The journey has three stages. In the first stage the train starts from rest at A and accelerates uniformly until its speed is $V \text{ m s}^{-1}$. In the second stage the train travels at constant speed $V \text{ m s}^{-1}$ for 600 s. During the third stage of the journey the train decelerates uniformly, coming to rest at B.

(i) Sketch the velocity-time graph for the train's journey.   [2]

(ii) Find the value of V.   [3]

(iii) Given that the acceleration of the train during the first stage of the journey is 0.15 m s^{-2}, find the distance travelled by the train during the third stage of the journey.   [4]

7 A particle P is held at rest at a fixed point O and then released. P falls freely under gravity until it reaches the point A which is 1.25 m below O.

(i) Find the speed of P at A and the time taken for P to reach A.   [3]

The particle continues to fall, but now its downward acceleration t seconds after passing through A is $(10 - 0.3t) \text{ m s}^{-2}$.

(ii) Find the total distance P has fallen, 3 s after being released from O.   [7]

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