TAYLOR'S COLLEGE

Wisdom • Integrity • Excellence

CAMBRIDGE 'A' LEVEL PROGRAMME

A2 TRIAL EXAMINATION AUGUST/SEPTEMBER 2006

(June 2005 Intake)

Monday **4 September 2006** **1.30 pm – 2.45 pm**

MATHEMATICS 9709/4

PAPER 4 Mechanics 1 (M1) 1 hour 15 minutes

Additional materials: Answer Booklet/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 name and class 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 ms^{-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 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.

[Turn over

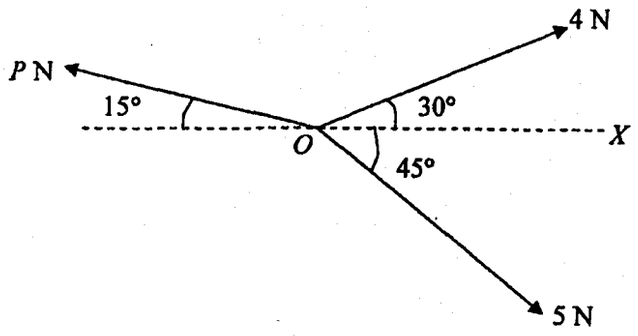
1. The total mass of a hot-air balloon and its content is 320 kg and the balloon is floating at a constant height. To obtain a vertical lift, a mass of 20 kg is dropped out. Calculate the acceleration of the balloon. [3]

2. A particles P moves in a straight line that passes though the origin O. The velocity of P at time t seconds is v ms^{-1} where $v = \frac{3}{2}\sqrt{t}$. At time t =0 the particle is at rest at a point whose displacement from O is −8 m.

   a) Find an expression for the displacement of P from O in terms of t. [3]

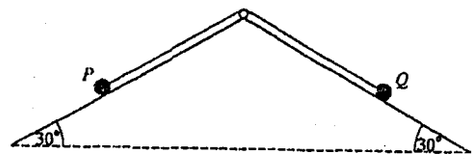
   b) Find the value of t for which the particle is at O. [2]

3.



The diagram shows three coplanar forces act at a point. The magnitude of the forces are 4 N, 5 N and P N, and the directions in which the forces act are shown in the diagram. The resultant of the three forces has a magnitude of R N and acts along OX. Find the value of P and R. [6]

4.



Particle P and Q of masses 0.3 kg and 0.2 kg respectively, are attached to the ends of a light inextensible string. The string passes over a fixed smooth peg with the particles P and Q on the planes inclined at 30° to the horizontal, as shown in the figure. The planes are equally rough and the coefficient of friction between each particle and the corresponding plane is μ. The system is released from rest with the parts of the string between the peg and the particles taut and parallel to lines of greatest slope. All resistance to motion, apart from friction between the particles and the planes, are negligible. Given that the particles are in limiting equilibrium, find μ. [6]

5. Two vehicles, moving in the same direction, pass the point O on a straight road at time $t = 0$. Vehicle A is moving at constant speed 11 ms^{-1}. Vehicle B has constant acceleration 2 ms^{-2}, and it has speed 3 ms^{-1} as it passes O.

Sketch on a single diagram the (t, v) graphs for vehicle A and B. [1]

Find

a) the distance from O at which B has speed 21ms^{-1}, [2]

b) the time, t seconds, when B overtakes A, [3]

c) the maximum distance by which A is ahead of B. [3]

[Turn Over

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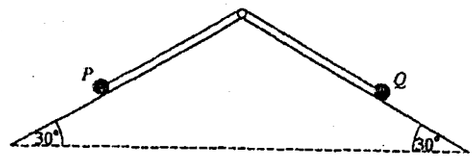

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[Turn Over

6. A car has mass 800 kg and its engine has constant power 40 kW. The car moves in a straight horizontal line, starting from rest. Ignoring all resistance, find the time taken to reach a speed of 20 ms^{-1}. [3]

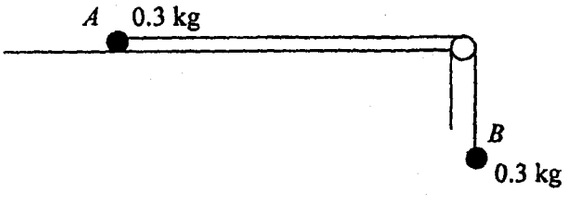
The car reaches a slope with an angle of $\sin^{-1}\left(\frac{1}{10}\right)$ which it climbs at a constant speed of 25 ms^{-1} against a resistance of 1600N.

a) What extra power must the car engine produce? [3]

While the car is climbing the slope at a speed of 25 ms^{-1} the power is suddenly removed and the car slows down and comes to rest.

b) How far along the slope does the car travel before coming to a stop? [4]

7.



The diagram shows two particles A and B, both of mass 0.3 kg connected by a light inextensible string which passes over a smooth fixed pulley. The system is held at rest with A on a rough horizontal table and B hanging vertically. Given that the coefficient of friction between A and the table is 0.4 and that the system is released from rest.

a) Find the acceleration of the particles. [5]

Particle B hits the floor 0.6 s after it starts to move, and does not rebound upwards.

b) Show that B hits the floor with a speed of 1.8 ms^{-1}. [1]

c) Given that A was originally 1 m from the pulley, determine whether A will reach the pulley. [5]