TAYLOR'S UNIVERSITY COLLEGE
Wisdom · Integrity · Excellence

CAMBRIDGE A LEVEL PROGRAMME

A2 TRIAL EXAMINATION AUGUST/SEPTEMBER 2009

(June 2008 Intake)

Wednesday **2 September 2009** **8.30am – 9.45 am**

MATHEMATICS 9709/42

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.

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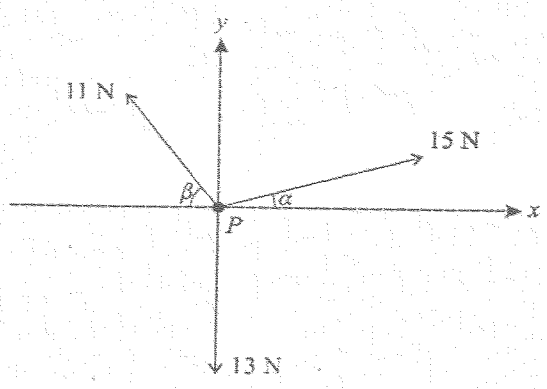
1



Three horizontal forces of magnitude 15N, 11N and 13N act on a particle P in the direction shown in the diagram. The angles α and β are such that $\sin\alpha = 0.28$, $\cos\alpha = 0.96$, $\sin\beta = 0.8$ and $\cos\beta = 0.6$.

(i) Show that the component, in the y-direction, of the resultant of the three forces is zero. [3]

(ii) Find the magnitude of the resultant of the three forces. [2]

2 A particle P is projected vertically upwards, from horizontal ground, with speed 8.4 ms^{-1}.

(i) Show that the greatest height above the ground reached by P is 3.53 metres, correct to three significant figures. [3]

A particle Q is projected vertically upwards, from a point 2 metres above the ground, with speed $u\,ms^{-1}$. The greatest height above the ground reached by Q is also 3.53 metres.

(ii) Find the value of u. [2]

3 A particle of mass 4 kg is pushed up a plane inclined at an angle of $\sin^{-1}(\frac{1}{10})$ to the horizontal .The coefficient of friction between the particle and the plane is 0.2.The particle has an initial speed of 5 ms^{-1}. It travels a distance 20 metres up a line of greatest slope of the plane and the speed then is 3 ms^{-1}. Find the

(i) Work done against the frictional force. [2]

(ii) Work done against gravity. [2]

(iii) Total work done by the push. [3]

4 A cyclist travels along a straight road. Her velocity v ms^{-1}, a t time t seconds after starting from a point O, is given by

$v = 2$ for $0 \le t \le 10$

$v = 0.03t^2 - 0.3t + 2$ for $t \ge 10$

(i) Find the displacement of the cyclist from the point O when $t = 10$. [1]

(ii) Find an expression for the displacement of the cyclist from O for the time where $t \ge 10$. [3]

(iii) Find the displacement of the cyclist from O when her acceleration is $0.6\,ms^{-2}$. [4]

5 The resistance to the motion of a car of mass 600 kg is kv N where v ms^{-1} is the car's speed and k is a constant. The car ascends a hill of inclination α, where $\sin\alpha = \frac{1}{10}$. The power exerted by the car's engine is 14000 W and the car has constant speed $20\,ms^{-1}$.

(i) Show that $k = 5$. [3]

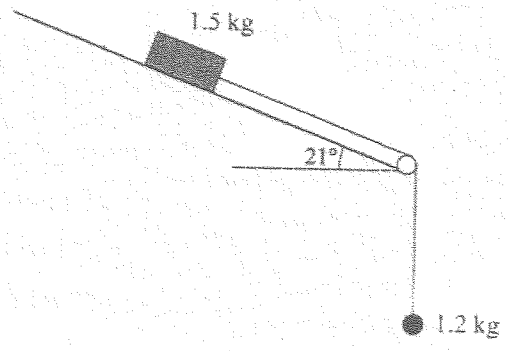
If the power exerted by the car's engine is increased to 16000 W.

(ii) Calculate the maximum speed of the car while ascending the hill. [3]

The car now travels on a horizontal ground and the power remains 16000 W.

(iii) Calculate the acceleration of the car at an instant when its speed is $32\,ms^{-1}$. [2]

6



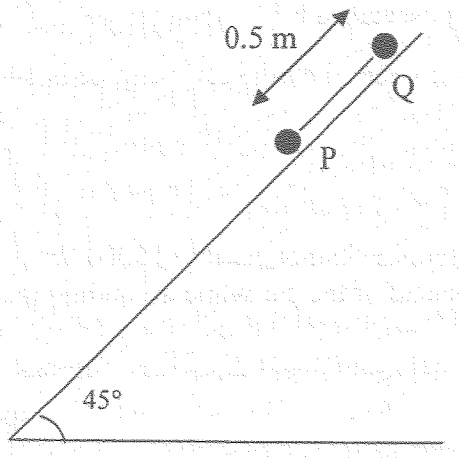
One end of a light inextensible string is attached to a block of mass 1.5 kg. The other end of the string is attached to an object of mass 1.2 kg. The block is held at rest in contact with a rough plane inclined at 21° to the horizontal. The string is taut and passes over a small smooth pulley at the bottom edge of the plane. The part of the string above the pulley is parallel to a line of greatest slope of the plane and the object hangs freely below the pulley (see diagram). The block is released and the object moves vertically downwards with acceleration a ms^{-2}. The tension in the string is T N. The coefficient of friction between the block and the plane is 0.8.

(i) Show that the frictional force acting on the block has magnitude 11.2 N, correct to 3 significant figures. [2]

(ii) By applying Newton's second law to the block and to the object, find a pair of simultaneous equations in T and a. [4]

(iii) Hence, show that $a = 2.29$, correct to 2 decimal places. [2]

7



Two particles P and Q are joined by a taut light inextensible string, which is parallel to a line of greatest slope on an inclined plane on which the particles are initially held at rest. The string is 0.5m long and the plane is inclined at 45° to the horizontal. P is below the level of Q (see diagram). Each particle has mass 0.2kg. Contact between P and the plane are smooth. The coefficient of friction between Q and the plane is 1. The particles are released from rest and begin to move down the plane.

(i) Show that the magnitude of the frictional force acting on Q is 1.414 N, correct to 4 significant figures. [2]

(ii) Show that the particles accelerate at 3.536 ms^{-2}, correct to 4 significant figures, and calculate the tension in the string. [5]

(iii) Calculate the speed of the particles at the instant when Q reaches the initial position of P. [2]