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CAMBRIDGE A LEVEL PROGRAMME

A2 TRIAL EXAMINATION MARCH/APRIL 2011

(January/March 2010 Intakes)

Wednesday **30 March 2011** **8.30 am – 9.45 am**

MATHEMATICS 9709/43

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.

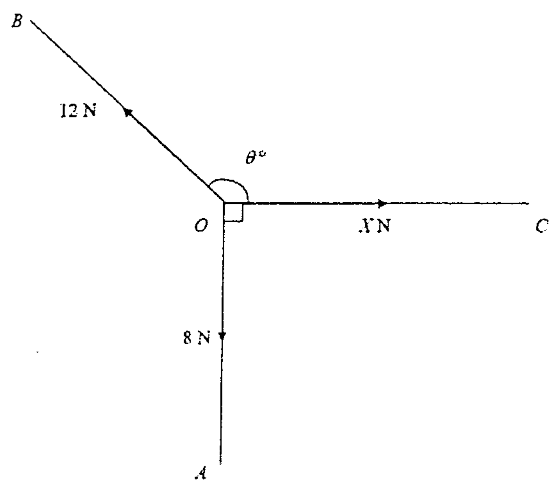
This document consists of **4** printed pages.

 [Turn over

1 A particle of mass 4 kg is moving in a straight horizontal line. There is a constant resistive force of magnitude R newton. The speed of the particle is reduced from $25ms^{-1}$ to rest over a distance of 200 m. Use the work-energy principle to calculate the value of R. [3]

2

Figure 1



In Figure 1, $\angle AOC = 90°$ and $\angle BOC = \theta°$. A particle at O is in equilibrium under the action of three coplanar forces. The three forces have magnitude 8 N, 12 N and x N and act along OA, OB and OC respectively. Calculate the

(i) value of θ. [2]

(ii) value of x. [2]

3 A particle P of mass 2 kg moves on the x-axis under the action of a variable force. At time t seconds the displacement of P from the origin O is x metres. It is given that

$$\frac{dx}{dt} = t^2 - 5t + 4$$

and the $x = 2$ when $t = 0$.

(i) Find x in terms of t. [3]

(ii) Find the coordinates of the maximum and minimum points on the x-t graph [2]

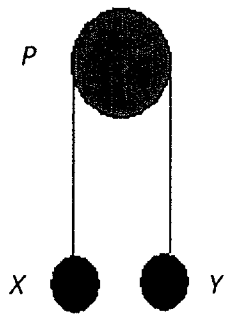
(iii) State the number of times that P passes through O after $t = 0$. [1]

4 Two particles X and Y, of masses m and $4m$ respectively, are attached to the ends of a light inextensible string of length $8l$. The string hangs over a smooth fixed pulley P, and the particles are released from rest when hanging at the same level (Figure 2).

(i) Find the distance between the particles at the instant when they are each moving at a speed of $\sqrt{3gl}$. [4]

(ii) Find also the total loss in energy of the particles up to this instant. [3]

Figure 2



5 The resistance to motion of a car, of mass 1500 kg, has magnitude $(Av + Bv^2)$ newtons, where A and B are constants and v is the speed in ms^{-1}. The maximum power of the car engine is 30 kW. The maximum speed on a horizontal road is 50 ms^{-1}.

(i) Show that $A + 50B = 12$. [4]

(ii) When travelling uphill on a road inclined at an angle α to the horizontal, where $sin\alpha = \frac{1}{20}$, the maximum speed is 30ms^{-1}. Show that $A + 30B = \frac{25}{3}$. [2]

(iii) Hence, find the values of A and B. [2]

[Turn over

6 A parachutist drops from a helicopter with distance **H** from ground, and falls vertically from rest towards the ground. Her parachute opens 2s after she leaves **H** and her speed then reduces to 4ms^{-1}. For the first 2s her motion is modeled as that of a particle falling freely under gravity. For the next 5s the model is motion with constant deceleration, so that her speed is 4 ms^{-1} at the end of this period. For the rest of the time before she reaches the ground, the model is motion with constant speed of 4 ms^{-1}.

(i) Sketch a speed-time graph to illustrate her motion from **H** to the ground. [3]
(ii) Find her speed when the parachute opens. [2]

A safety rule states that the helicopter must be high enough to allow the parachute to open and for the speed of a parachutist to reduce to 4 ms^{-1} before reaching the ground. Using the assumptions made in the above model,

(iii) Find the minimum height of **H** for which the woman can make a drop without breaking this safety rule. [4]

7

Figure 3

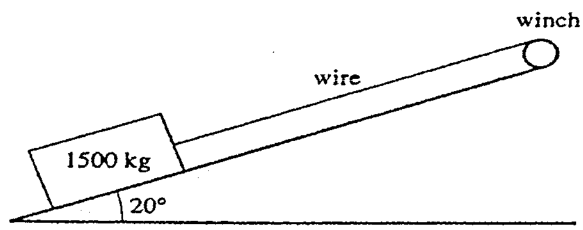
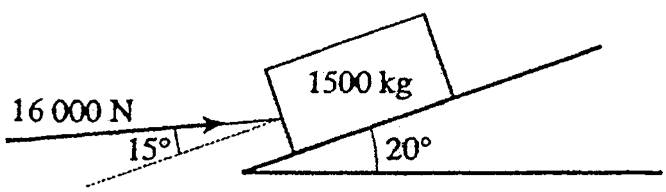


Figure 3 shows a winch pulls a crate of mass 1500 kg up a slope at 20^0 to the horizontal. The light wire attached to the winch and the crate is parallel to the slope. The crate takes 50 seconds to move 25 m up the slope at a constant speed when the power supplied by the winch is 6 kW.

(i) How much work is done by the tension in the wire in the 50 seconds? [1]
(ii) Calculate the resistance to the motion of the crate up the slope. [3]
(iii) Show that the coefficient of friction between the crate and the slope is 0.49 (correct to two significant figures). [2]

Figure 4



(iv) Based on Figure 4, calculate the distance travelled by the crate up the slope as it speeds up from rest to 2.5 ms^{-1}.(you may assume the coefficient of friction between the crate and the slope is exactly 0.49). [7]