UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Level 3 Pre-U Certificate
Principal Subject

MATHEMATICS **9794/03**

Paper 3 Applications of Mathematics **May/June 2013**

2 hours

Additional Materials: Answer Booklet/Paper
Graph Paper
List of Formulae (MF20)

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 80.
You are advised to spend no more than 1 hour on Section A and 1 hour on Section B.

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

[Turn over

Section A: Probability (40 marks)

You are advised to spend no more than 1 hour on this section.

1 Pupils at a certain school carried out a survey of traffic passing the school during a two-hour period one morning. One pupil recorded the number of people in each of the first 100 cars. Her results were as follows.

Number of people	1	2	3	4	5
Number of cars	48	26	14	10	2

Find the mean and the standard deviation of the number of people per car in her sample. [4]

2 Events A and B are such that $\mathrm{P}(A) = \frac{1}{2}$, $\mathrm{P}(A \cup B) = \frac{5}{6}$ and $\mathrm{P}(B \mid A) = \frac{1}{4}$.

Find

(i) $\mathrm{P}(A \cap B)$, [2]

(ii) $\mathrm{P}(B)$. [2]

3 At a local athletics club, data on the ages of the members and their times to run a 10 km course are recorded. For a random sample of 25 club members aged between 20 and 60, their ages (x years) and times (y minutes) are summarised as follows.

$$n = 25 \qquad \Sigma x = 1002 \qquad \Sigma x^2 = 43\,508 \qquad \Sigma y = 1865 \qquad \Sigma y^2 = 142\,749 \qquad \Sigma xy = 77\,532$$

(i) Calculate the product moment correlation coefficient for these data. [4]

(ii) Show that the equation of the least squares regression line of y on x is $y = 0.83x + 41.28$, where the coefficients are given correct to 2 decimal places. [4]

(iii) Use the equation given in part **(ii)** to estimate the time taken by someone who is

(a) 50 years old,

(b) 65 years old.

Comment on the validity of each of these estimates. [4]

4 A tomato grower grows just one variety of tomatoes. The weights of these tomatoes are found to be normally distributed with a mean of 85.1 grams and a standard deviation of 3.4 grams.

(i) Find the probability that a randomly chosen tomato of this variety weighs less than 80 grams. [3]

(ii) The grower puts the tomatoes in packs of 6. Find the probability that, in a randomly chosen pack of 6, at most one tomato weighs less than 80 grams. [4]

(iii) The grower supplies consignments of 250 packs of these tomatoes to a retailer. For a randomly chosen consignment, find the expected number of packs having **more** than one tomato weighing less than 80 grams. [3]

5 A game is played with cards, each of which has a single digit printed on it. Eleanor has 7 cards with the digits 1, 1, 2, 3, 4, 5, 6 on them.

(i) How many different 7-digit numbers can be made by arranging Eleanor's cards? [3]

(ii) Eleanor is going to select 5 of the 7 cards and use them to form a 5-digit number. How many different 5-digit numbers are possible? [7]

Section B: Mechanics (40 marks)

You are advised to spend no more than 1 hour on this section.

6 A particle travels along a straight line. Its velocity $v\,\text{m s}^{-1}$ after t seconds is given by

$$v = t^3 - 6t^2 + 8t \text{ for } 0 \leqslant t \leqslant 4.$$

When $t = 0$ the particle is at rest at the point P.

(i) Find the times (other than $t = 0$) when the particle is at rest. Sketch the velocity-time graph for $0 \leqslant t \leqslant 4$. [4]

(ii) Find the acceleration of the particle when $t = 2$. [3]

(iii) Find an expression for the displacement of the particle from P after t seconds. Hence state its displacement from P when $t = 2$ and find its average speed between $t = 0$ and $t = 2$. [6]

7 A particle A of mass $4m$, on a smooth horizontal plane, is moving with speed u directly towards another particle B, of mass $2m$, which is at rest. The coefficient of restitution between the two particles is e.

(i) Show that, after the collision, the velocity of A is $\frac{1}{3}(2 - e)u$ and find the velocity of B. [4]

(ii) Hence write down their velocities in the case when $e = \frac{1}{2}$. [1]

Particle B now collides directly with a third particle C, of mass m, which is at rest. The coefficient of restitution in both collisions is $\frac{1}{2}$.

(iii) Use your answers to part **(ii)** to find the velocities of A, B and C after the second collision has taken place. [2]

(iv) Explain briefly whether any further collisions take place. [1]

[Questions 8 and 9 are printed on the next page.]

[Turn over

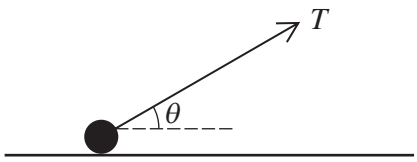
8 A particle is projected from a point O with initial speed U at an angle θ above the horizontal. At time t after projection the position of the particle is (x, y) relative to horizontal and vertical axes through O.

(i) Write down expressions for x and y at time t. Hence derive the cartesian equation of the trajectory of the particle. [4]

(ii) A player in a cricket match throws the ball with speed $30\ \text{m s}^{-1}$ to another player who is 45 metres away. Assume that the players throw and catch the ball at the same height above the ground. Show that there are two possible trajectories and find their respective angles of projection. [4]

(iii) Describe briefly one advantage of each trajectory. [2]

9 A particle of mass m kg rests in equilibrium on a rough horizontal table. There is a string attached to the particle. The tension in the string is T N at an angle of θ to the horizontal, as shown in the diagram.



(i) Copy and complete the diagram to show all the forces acting on the particle. [1]

(ii) The coefficient of friction between the particle and the table is μ and the particle is on the point of slipping. Show that $T = \dfrac{\mu mg}{\cos\theta + \mu \sin\theta}$. [4]

(iii) Given that $\mu = 0.75$, find the value of θ for which T is a minimum. [4]