Cambridge Pre-U

Cambridge International Examinations
Cambridge Pre-U Certificate

MATHEMATICS (PRINCIPAL) **9794/03**

Paper 3 Applications of Mathematics **May/June 2017**

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

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

CAMBRIDGE International Examinations

[Turn over

Section A: Probability (40 marks)

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

1 Levels of nitrogen dioxide in the atmosphere are being monitored at the side of a road in a busy city centre. A sample of 18 measurements taken (in suitable units) is as follows.

83 44 95 92 98 63 69 76 19 91 70 91 74 65 62 70 95 108

(i) Find the mean and standard deviation of the sample. [2]

(ii) Hence identify, with justification, any possible outliers. [3]

2 The table shows the turnover, in millions of pounds, of a small company at 3-year intervals over a period of 15 years, starting in 2000.

Year since 2000	0	3	6	9	12	15
Turnover (£ millions)	2.30	2.94	3.37	3.97	4.93	6.13

(i) For the information in the table find the equation of the least squares regression line of y on x, where x is the year since 2000 and y is the turnover in millions of pounds. [5]

(ii) Use the equation of the regression line to calculate the residual for 2009. [2]

(iii) Use the equation of the regression line to estimate the turnover in 2024, and explain why it is inadvisable to rely on this estimate. [2]

3 The probability distribution of the discrete random variable X is defined as follows.

$$\mathrm{P}(X = x) = k(2 + x)(5 - x) \quad \text{for } x = 0,\ 1,\ 2,\ 3,\ 4$$

(i) Show that $k = \frac{1}{50}$. [2]

(ii) Find the variance of X. [4]

(iii) Find $\mathrm{P}(X = 4 \mid X > 0)$. [2]

4 The letters of the word 'STATISTICS' are to be rearranged.

(i) How many distinct arrangements are there? [3]

(ii) How many of the arrangements start and end with the letter S? [3]

(iii) What is the probability that, in a randomly chosen arrangement, the S's are all together? [3]

5 The random variable X has a geometric distribution: $X \sim \text{Geo}(p)$.

(i) Show that $\text{P}(X > n) = q^n$, where $q = 1 - p$. [3]

You are given that $\text{P}(X \geqslant 4) = 0.216$.

(ii) Use the result given in part **(i)** to find the value of p and $\text{P}(X \leqslant 8)$. [4]

(iii) Write down $\text{E}(X)$ and $\text{Var}(X)$. [2]

Section B: Mechanics (40 marks)

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

6 A crate, which has a mass of 220 kg, is being lowered on the end of a cable onto the back of a lorry.

(i) Draw a diagram to show the forces acting on the crate. [1]

The crate is lowered in three stages.

Stage 1 It starts from rest and accelerates at $1.5\,\text{m}\,\text{s}^{-2}$ until it reaches a speed of $3\,\text{m}\,\text{s}^{-1}$.

Stage 2 It descends at a constant speed of $3\,\text{m}\,\text{s}^{-1}$.

Stage 3 It decelerates at $0.75\,\text{m}\,\text{s}^{-2}$ and eventually comes to rest.

(ii) Find the tension in the cable in each of the three stages. [4]

(iii) Sketch the velocity-time graph for the complete downward motion of the crate. [2]

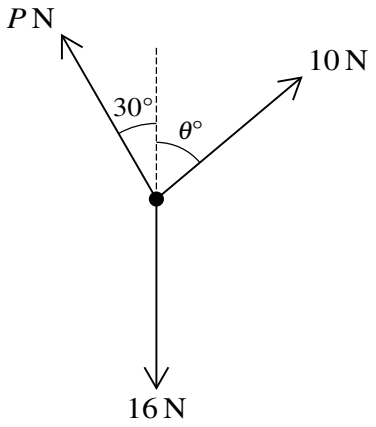
(iv) The crate is lowered 15 m altogether. By considering your velocity-time graph, find the total time taken. [5]

7 A building 33.8 m high stands on horizontal ground. A particle is projected horizontally from the top of the building and hits the ground 31.2 m away.

(i) Find the initial speed of the particle. [4]

(ii) Find the magnitude and direction of the velocity of the particle when it hits the ground. [5]

8 An object of weight 16 N is supported in equilibrium by a force of P N at 30° to the vertical and by another of 10 N at θ° to the vertical as shown in the diagram.



(i) Draw a triangle to show that the forces acting on the object are in equilibrium. [1]

(ii) Find the two possible values of θ and the corresponding values of P. [5]

9 A particle moves along a straight line such that its displacement from O, a fixed point on the line, is x. The particle travels from rest from the point P, where $x = 2$, to the point Q, where $x = 5.6$. All distances are in metres. Two models for the motion of the particle are proposed.

(i) In Model 1, the acceleration of the particle is assumed to be constant and the particle takes 18 seconds to travel from P to Q. Find the velocity of the particle when it reaches Q. [2]

(ii) In Model 2, the velocity after t seconds is v m s^{-1}, where $v = \frac{1}{270}(18t - t^2)$.

(a) Write down the values of t when $v = 0$. [1]

(b) Show that $x = 5.6$ when $t = 18$. [4]

(iii) The particle represents a fragile instrument that is being moved from P to Q across a laboratory. Explain why Model 2 might be more appropriate than Model 1. [1]

10 A cyclist travelling at a steady speed of 4 m s^{-1} passes a bus which is at rest at a bus stop. 5 seconds later the bus sets off following the cyclist and accelerating at $\frac{1}{2}$ m s^{-2}. How soon after setting off does the bus catch up with the cyclist? How fast is the bus going at this time? [5]