
MATHEMATICS (PRINCIPAL)

9794/03

Paper 3 Applications of Mathematics

May/June 2019

2 hours

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

* 7 5 5 6 1 0 0 0 6 7 *

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 m s^{-2} .

The use of an electronic calculator is expected, where appropriate.

You are reminded of the need for clear presentation in your answers.

There is an insert for Question 3.

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.

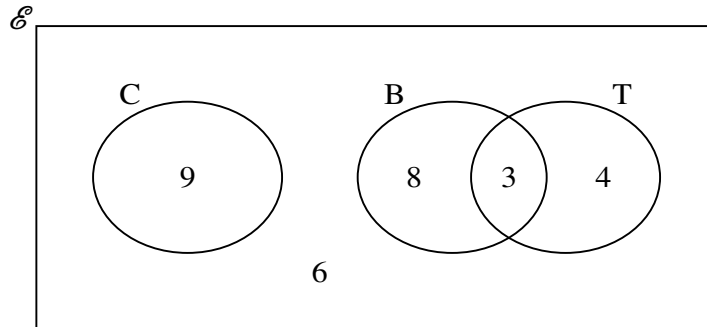
This syllabus is regulated for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document consists of **5** printed pages, **3** blank pages and **1** insert.

Section A: Probability (40 marks)

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

1



There are 30 students in a Mathematics class. The diagram shows the numbers of these students who travelled to school by bicycle (B), car (C) and train (T) on the first day of term.

- (a) One student is chosen at random. Find the probability that this student travelled to school
- (i) by car, [1]
 - (ii) by both bicycle and train, [1]
 - (iii) by bicycle, given that the student travelled by train. [1]
- (b) Determine whether travelling by bicycle and travelling by train are independent events. [2]

2 Jane installs smart meters for an electricity company. The time Jane takes to install the meters is normally distributed with mean 50 minutes and standard deviation 15 minutes.

- (a) Calculate the probability that Jane takes less than 55 minutes to install a meter. [2]
- (b) Calculate the probability that Jane takes between 30 and 60 minutes to install a meter. [3]
- (c) The probability that Jane takes more than t minutes to install a meter is 0.05. Find t . [3]

- 3 The data for the total number of registered cars, x million, and the total number of road traffic injuries, y hundred thousand, for 10 consecutive years in the UK are shown in the table below.

	x	y
1945	2.6	1.38
1946	3.1	1.63
1947	3.5	1.66
1948	3.7	1.53
1949	4.1	1.77
1950	4.4	2.01
1951	4.6	2.16
1952	4.9	2.08
1953	5.3	2.26
1954	5.8	2.38

The insert shows the scatter graph for these data.

The data is summarized as $\Sigma x = 42$, $\Sigma y = 18.86$, $\Sigma x^2 = 185.38$, $\Sigma y^2 = 36.5948$ and $\Sigma xy = 82.123$.

- (a) Show that the regression line of y on x is

$$y = 0.525 + 0.324x,$$

where the coefficients are given to 3 significant figures.

Draw this line on the scatter graph on the insert. [4]

- (b) Mark the residuals for each point on the graph. [1]
- (c) State the sum of the residuals. [1]
- (d) The sum of the squares of the residuals for the 8 data points from 1945 to 1952 is 0.0803. Find the sum of the squares of the residuals for all 10 data points. [2]

- 4 From past experience, John knows that when he phones a particular customer services department he is connected immediately to an adviser 40% of the time. He ends the call if he is not connected immediately. John phones repeatedly on a given day until connected directly with a customer adviser. Let X be the random variable for the number of calls John makes on that day.

- (a) State two conditions for X to be modelled as a geometric distribution. [2]
- (b) Assuming X has the distribution $\text{Geo}(0.4)$, calculate
- (i) $P(X = 3)$, [2]
- (ii) $P(X > 3)$. [2]

John phones the customer services department on 6 different days.

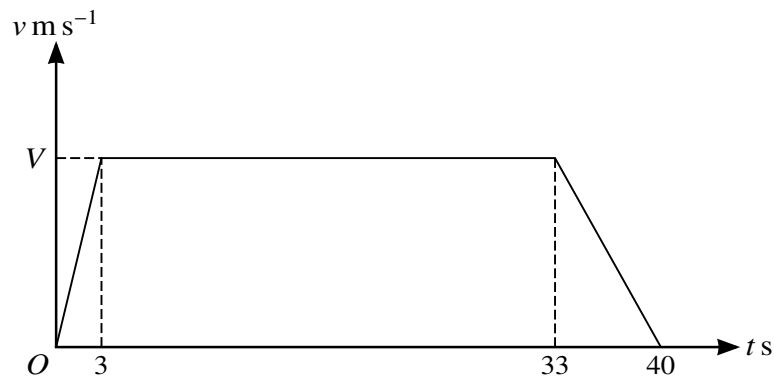
- (c) Find the probability that it takes more than 3 attempts to connect directly with a customer adviser on exactly 2 of those days. [3]

- 5 A teacher has 12 books on a shelf. There are 7 mechanics books A, B, C, D, E, F and G. There are 5 statistics books V, W, X, Y and Z.
- (a) Find the number of different ways of arranging the 12 books on the shelf. [1]
- (b) Find the number of different ways of arranging the books on the shelf if all the mechanics books are together and all the statistics books are together. [2]
- (c) The books are arranged at random on the shelf. Find the probability that all the statistics books are together. [4]
- (d) The books are now placed on the shelf with the mechanics books together at the left end and the statistics books together at the right end. Within each section the books can be arranged at random. Find the probability that book A and book Z have at least 9 books between them. [3]

Section B: Mechanics (40 marks)

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

6



The diagram shows the velocity-time graph of the journey of a bus between two bus stops P and Q . The bus starts from rest at P and accelerates at 4 m s^{-2} for 3 s. The bus continues at constant speed, $V \text{ m s}^{-1}$, for a further 30 s. Then the bus decelerates uniformly for 7 s until it reaches Q . Find

- (a) the value of V , [1]
- (b) the distance PQ . [3]
- 7 A car, of mass 1900 kg, tows a caravan, of mass 800 kg, along a straight horizontal road. The caravan is attached to the car by a horizontal tow bar. A constant force of magnitude 500 N resists the motion of the car. A constant force of magnitude 400 N resists the motion of the caravan. The engine of the car produces a constant driving force of 2600 N. Find
- (a) the acceleration of the car, [3]
- (b) the magnitude of the force in the tow bar. [3]

- 8 A small ball B is projected with speed 44 m s^{-1} at an angle of 7° above the horizontal from a point O . At time t seconds after projection, the horizontal and vertically upwards displacements of B from O are x m and y m respectively.

- (a) Express x and y in terms of t , and hence show that the equation of trajectory of B is

$$y = 0.123x - 0.00262x^2,$$

where the coefficients are correct to 3 significant figures. [4]

Point O is 2.6 m above horizontal ground. The horizontal distance from O of a vertical wall is 12 m. The wall is perpendicular to the plane in which B moves. B just passes over the wall and subsequently strikes the ground at a point A .

- (b) Find the height of the wall and the distance of A from the base of the wall. [5]

- 9 A particle of mass 5 kg is moving up a line of greatest slope of a rough plane inclined at 16° to the horizontal. The particle passes through a point A on the slope with speed 5 m s^{-1} . The coefficient of friction between the particle and the plane is 0.4. The particle comes to rest at a point B on the plane.

- (a) Find the time taken for the particle to move from A to B . [7]

- (b) (i) Find the magnitude of the frictional force when the particle is at rest at B . [2]

- (ii) State, with a reason, the magnitude and direction of the contact force when the particle is at rest at B . [2]

- 10 Two particles A and B are moving in the same direction along a straight line on a smooth horizontal surface. A has mass 2 kg and speed 5 m s^{-1} . B has mass 3 kg and speed 1.5 m s^{-1} . A collides directly with B and the impulse that A exerts on B is 6 N s.

- (a) Find the speeds of A and B after the collision. [3]

B subsequently collides with a stationary particle C of mass m kg. The coefficient of restitution between B and C is 0.4.

- (b) Determine the range of values of m for which no further collisions occur. [7]

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