Cambridge Pre-U

MATHEMATICS **9794/03**

Paper 3 Applications of Mathematics **May/June 2022**

2 hours

0879036300

You must answer on the answer booklet/paper.

You will need: Answer booklet/paper
Graph paper
List of formulae (MF20)

INSTRUCTIONS

- Answer **all** questions.
- If you have been given an answer booklet, follow the instructions on the front cover of the answer booklet.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number on all the work you hand in.
- Do **not** use an erasable pen or correction fluid.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for 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 $10\,\mathrm{m\,s^{-2}}$.
- At the end of the examination, fasten all your work together. Do **not** use staples, paper clips or glue.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

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

This document has **4** pages.

Section A: Probability (40 marks)

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

1 The marks, x, awarded by a teacher to 28 students for a particular piece of work are summarised as follows.

$$\Sigma x = 1638, \qquad \Sigma x^2 = 108\,364$$

(a) Calculate the mean and standard deviation of these marks. [3]

The teacher finds that, compared to other teachers, she has marked too harshly. To bring her marking into line with the other teachers, she adds 4 to the mark of each student.

(b) Write down the mean and standard deviation of the new marks. [2]

2 Two events, A and B, are such that $\mathrm{P}(A) = \frac{1}{2}$, $\mathrm{P}(B) = \frac{7}{10}$ and $\mathrm{P}(A \mid B') = \frac{2}{3}$.

(a) Find $\mathrm{P}(A \cap B)$. [4]

(b) Find $\mathrm{P}(A \cup B)$. [2]

(c) State, with a reason, whether A and B are mutually exclusive. [1]

3 A discrete random variable X has the following distribution.

x	0	2	4	6
$\mathrm{P}(X = x)$	0.25	p	q	0.4

It is given that $\mathrm{E}(X) = 3.5$.

(a) Find p and q. [4]

(b) Find the variance of X. [2]

4 Patients' waiting times at a hospital A&E department are modelled by a normal distribution with standard deviation 1.8 hours. The waiting time is longer than 7 hours for 10% of the patients.

(a) Find the mean waiting time. [3]

(b) Find the probability that a randomly chosen patient waits less than 3 hours. [2]

5 **(a)** The 11 letters of the word RASPBERRIES are to be arranged.

(i) Find the number of different arrangements. [3]

(ii) Find the number of different arrangements if the 4 vowels are all together. [2]

(b) 4 of the 11 letters of the word RASPBERRIES are chosen at random. Find the probability that the 4 letters can be arranged to spell the word RIPE. [3]

6 A shop sells ball-point pens, of which 3% are faulty.

(a) **(i)** A random sample of 20 pens is taken. Find the probability that at most 2 pens are faulty. [3]

(ii) Five random samples of size 20 are taken. Find the probability that exactly three of the samples contain at most 2 pens that are faulty. [3]

(b) A random sample of n pens is taken. Find the smallest value of n such that there is a probability of at least 0.9 that the sample contains at least 1 faulty pen. [3]

Section B: Mechanics (40 marks)

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

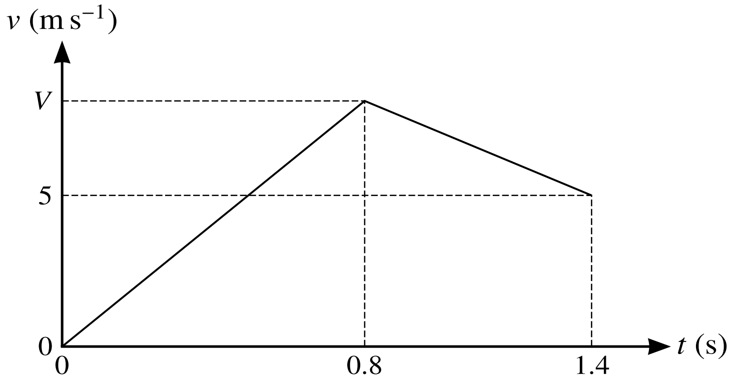
7 A block of mass 8 kg lies on a rough plane inclined at 30° to the horizontal. The coefficient of friction between the block and the plane is μ. A force of magnitude 25 N is applied to the block in a direction up the plane and along a line of greatest slope of the plane. This 25 N force is just sufficient to prevent the block sliding down the plane.

Find the value of μ. [5]

8 A light inextensible string connects two particles A and B, of masses 0.3 kg and 0.5 kg respectively. A is held with B vertically below A. Particle A is released and the system falls. The air resistance acting on A is 0.8 N and the air resistance acting on B is 0.6 N.

Find the acceleration of the particles and the tension in the string. [6]

9



The diagram shows the velocity-time graph for the motion of a small object, which falls vertically from rest at a point P above the surface of a reservoir. The velocity-time graph consists of two straight line segments.

The downward velocity of the object t s after leaving P is v m s^{-1}. The object hits the surface of the reservoir with velocity V m s^{-1} when $t = 0.8$. It reaches the bottom of the reservoir with velocity 5 m s^{-1} when $t = 1.4$.

(a) Given that there is no air resistance, find V. [1]

(b) Find the depth of the reservoir. [2]

(c) The resistance to the motion of the object in the reservoir has magnitude 6 N. Find the mass of the object. [4]

10 A particle is projected from a point P on horizontal ground with speed 45 m s^{-1} at $\theta°$ above the horizontal. The particle reaches the ground again, at point Q, 4 s after projection.

(a) Find θ and the distance PQ. [4]

(b) Find the greatest height above the ground reached by the particle. [2]

(c) Find the length of time for which the direction of motion is between 10° above the horizontal and 10° below the horizontal. [4]

11 Two particles A and B, of masses m and $3m$ respectively, move on a smooth horizontal surface. A is moving with speed u when it collides directly with B, which is at rest. The coefficient of restitution between A and B is e. The direction of A is reversed by the collision.

(a) Find, in terms of u and e, the speed of A and the speed of B immediately after the collision. [7]

Subsequently, B collides directly with a smooth vertical wall and rebounds. The coefficient of restitution between B and the wall is $\frac{1}{2}$. There is a second collision between A and B.

(b) Show that $\frac{1}{3} < e < \frac{3}{5}$. [5]