Cambridge Assessment International Education

Cambridge Pre-U

MATHEMATICS **9794/03**

Paper 3 Applications of Mathematics **October/November 2020**

2 hours

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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 $10\,\text{m}\,\text{s}^{-2}$.
- 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.

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Section A: Probability (40 marks)

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

1 Events A and B are such that $P(A) = 0.6$, $P(B) = 0.3$ and $P(B \mid A) = 0.4$.

Calculate

(a) $P(A \cap B)$, [1]

(b) $P(A \cup B)$, [2]

(c) $P(A' \mid B)$. [3]

2 A committee of 4 people is chosen from a group of 6 men and 9 women. Find the number of ways of choosing the committee if

(a) its members are either all men or all women, [2]

(b) it contains both men and women, with at least as many women as men. [3]

3 Two variables x and y are such that, for a sample of 10 pairs of values,

$$\Sigma x = 19, \quad \Sigma y = 26.4, \quad \Sigma x^2 = 39.4 \quad \text{and} \quad \Sigma y^2 = 70.84.$$

The regression line of y on x has gradient $\frac{4}{15}$.

(a) Write down the coordinates of the point of intersection of the regression line of y on x and the regression line of x on y. [1]

(b) Find Σxy. [4]

4 The random variable X is distributed $B(n, p)$, but n and p are unknown. A large sample of values of X has mean 12.8 and standard deviation 1.6. Calculate an estimate of $P(X = 14)$. [6]

5 Joanne cycles to school from home and uses either route R or route S. Her journey time by route R is normally distributed with mean 25 minutes and standard deviation 2 minutes.

(a) Calculate the probability that her journey time by route R is

(i) less than 28 minutes, [2]

(ii) between 24 minutes and 26 minutes. [3]

Her journey time by route S is normally distributed with mean 26 minutes and standard deviation σ minutes.

(b) Given that the probability that her journey time by route S takes more than 29 minutes is 0.1, find the value of σ. [3]

On a particular day, Joanne leaves home at 8.02 am to cycle to school.

(c) Given that she needs to arrive at school by 8.30 am, determine which route she should take, justifying your answer. [2]

6 Catriona is a cricket player and is practising her bowling. She projects (bowls) a ball at a set of wooden poles (the stumps), attempting to hit them. Each time she bowls the ball, the probability that she will hit the stumps is 0.6, independently of previous attempts.

(a) Calculate the probability that she hits the stumps for the first time with her fourth attempt. [2]

John is also a cricket player. Each time he bowls the ball, the probability that he will hit the stumps is 0.3, independently of previous attempts. John's and Catriona's attempts are independent of each other. John and Catriona play a practice game in which they bowl alternately at the stumps. The winner is the player who hits the stumps first.

(b) Given that John bowls first, calculate the probability that Catriona

(i) wins the game with her first attempt, [1]

(ii) wins the game with her second attempt, [2]

(iii) wins the game. [3]

Section B: Mechanics (40 marks)

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

7 A particle of mass 0.2 kg is placed on a rough plane inclined at 20° to the horizontal. The particle is released and moves down the plane with acceleration $0.8\,\text{m}\,\text{s}^{-2}$. Find the coefficient of friction between the particle and the plane. [5]

8 Two particles A and B, of masses 3 kg and 4 kg respectively, are moving towards each other in the same straight line on a smooth horizontal surface. The speed of A is $2\,\text{m}\,\text{s}^{-1}$ and the speed of B is $1\,\text{m}\,\text{s}^{-1}$. The particles collide. The coefficient of restitution between A and B is 0.75.

(a) Find the speeds of A and B after the collision. [7]

(b) Find the magnitude of the impulse that each particle exerts on the other. [2]

9 A particle P moves in a straight line on a horizontal surface. At time t s after leaving a point O, it has velocity v m s^{-1}, where $v = 6t^{\frac{1}{2}} - 2t$.

(a) Find the maximum velocity of P. [4]

(b) Find the displacement of P from O when $t = 4$. [4]

10 Two particles A and B, of masses 3 kg and m kg respectively, where $m > 3$, are attached to the ends of a light inextensible string. The string passes over a smooth fixed pulley. A is held at rest with the string taut and both straight parts of the string vertical. A is released with both particles at a height 1.5 m above horizontal ground. The acceleration of the system is 2 m s^{-2}.

(a) Find the value of m. [5]

The string breaks 0.5 s after the particles are released. A does not reach the pulley in the subsequent motion.

(b) Find the speed of A immediately before it hits the ground. [4]

11 A particle P is projected from the top of a vertical cliff with speed 14 m s^{-1} at 60° above the horizontal. At the same instant, a particle Q is projected from the bottom of the cliff with speed 25 m s^{-1} at α° above the horizontal. The height of the cliff is 40 m. P and Q move in the same vertical plane and eventually collide.

(a) Show that $\cos \alpha° = \frac{7}{25}$. [2]

(b) Determine whether Q is rising or falling immediately before the collision. [7]