Cambridge Assessment International Education

Cambridge Pre-U

MATHEMATICS **9794/03**

Paper 3 Applications of Mathematics **For examination from 2020**

SPECIMEN PAPER **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.
- Follow the instructions on the front cover of the answer booklet. If you need additional answer paper, ask the invigilator for a continuation booklet.
- 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 $10\,\text{m}\,\text{s}^{-2}$

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 **6** pages. Blank pages are indicated.

Section A: Probability (40 marks)

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

1 The times for a motorist to travel from home to work are normally distributed with a mean of 24 minutes and a standard deviation of 4 minutes. Find the probability that a particular trip from home to work takes

(a) more than 27 minutes, [3]

(b) between 20 and 25 minutes. [3]

2 **(a)** A music club has 200 members. 75 members play the piano, 130 members like Elgar, and 30 members do not play the piano, nor do they like Elgar.

(i) Calculate the probability that a member chosen at random plays the piano but does not like Elgar. [3]

(ii) Calculate the probability that a member chosen at random plays the piano given that this member likes Elgar. [2]

(b) The music club is organising a concert. The programme is to consist of 7 pieces of music which are to be selected from 9 classical pieces and 6 modern pieces. Find the number of different concert programmes that can be produced if

(i) there are no restrictions, [2]

(ii) the programme must consist of 5 classical pieces and 2 modern pieces, [2]

(iii) there are to be more modern pieces than classical pieces. [3]

3 The table shows fuel economy figures in miles per gallon (mpg) for some new cars.

Car	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Mpg	57	40	34	33	11	17	30	27	31	20	35	24	26	23	32

(a) Find the median and quartiles for the mpg of these 15 cars. [2]

(b) Use the values in part **(a)** to identify any cars for which the mpg is an outlier. [3]

4 A survey into left-handedness found that 13% of the population of the world are left-handed.

(a) State the assumptions necessary for it to be appropriate to model the number of left-handed children in a class of 20 children using the binomial distribution B(20, 0.13). [2]

(b) Assuming that this binomial model is appropriate, calculate the probability that fewer than 13% of the 20 children are left-handed. [4]

5 James plays an arcade game. Each time he plays, he puts a £1 coin in the slot to start the game. The possible outcomes of each game are as follows:

James loses the game with a probability of 0.7 and the machine pays out nothing,
James draws the game with a probability of 0.25 and the machine pays out a £1 coin,
James wins the game with a probability of 0.05 and the machine pays out ten £1 coins.

The outcomes can be modelled by a random variable X representing the number of £1 coins gained at the end of a game.

(a) Construct a probability distribution table for X. [2]

(b) Show that $E(X) = -0.25$ and find $\text{Var}(X)$. [4]

James starts off with 10 £1 coins and decides to play exactly 10 games.

(c) Find the expected number of £1 coins that James will have at the end of his 10 games. [2]

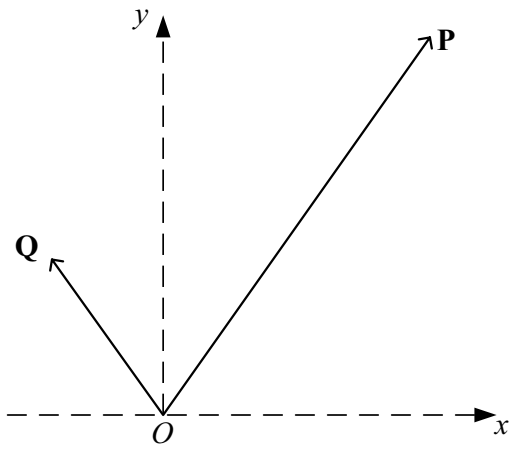
(d) Find the probability that after his 10 games James will have at least 10 £1 coins left. [3]

TURN OVER FOR SECTION B

Section B: Mechanics (40 marks)

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

6



The diagram shows two horizontal forces **P** and **Q** acting at the origin O of rectangular coordinates Oxy. The components of **P** in the x- and y-directions are 12 N and 17 N respectively. The components of **Q** in the x- and y-directions are –5 N and 7 N respectively.

(a) Write down the components, in the x- and y-directions, of the resultant of **P** and **Q**. [2]

(b) Hence, or otherwise, calculate the magnitude of this resultant and the angle the resultant makes with the positive x-axis. [4]

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

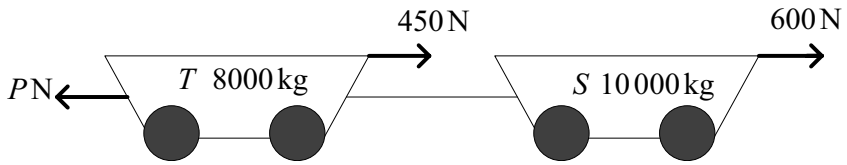
$$v = t^3 - 9t^2 + 20t$$

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

(a) Find the times, other than $t = 0$, at which the particle is at rest. [2]

(b) Find the displacement of the particle from P when $t = 2$. [4]

8 Two trucks, S and T, of masses 8000 kg and 10 000 kg respectively, are pulled along a straight, horizontal track by a constant, horizontal force of P N. A resistive force of 600 N acts on S and a resistive force of 450 N acts on T. The coupling between the trucks is light and horizontal (see diagram).



The acceleration of the system is $0.3\,\text{m s}^{-2}$ in the direction of the pulling force of magnitude P.

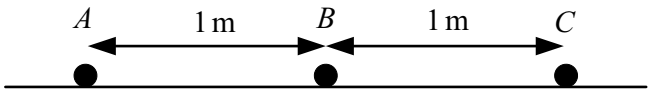
(a) Calculate the value of P. [2]

Truck S is now subjected to an extra resistive force of 1800 N. The pulling force, P, does not change.

(b) Calculate the new acceleration of the trucks. [2]

(c) Calculate the force in the coupling between the trucks. [2]

9



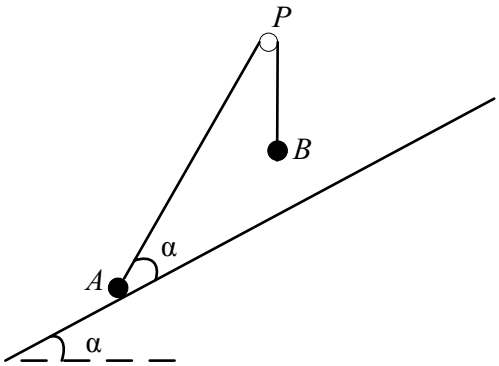
Three particles A, B and C, having masses of 1 kg, 2 kg and 5 kg respectively, are placed 1 metre apart in a straight line on a smooth horizontal plane (see diagram). The particles B and C are initially at rest and A is moving towards B with speed $14\,\text{m s}^{-1}$. The coefficient of restitution between each pair of particles is 0.5.

(a) Find the velocity of B immediately after the first impact and show that A comes to rest. [4]

(b) Show that B reversed direction after the impact with C. [3]

(c) Find the distances between B and C at the instant that B collides with A for the second time. [3]

10



Particles A and B of masses $2m$ and m, respectively, are attached to the ends of a light inextensible string. The string passes over a smooth fixed pulley P. The particle A rests in equilibrium on a rough plane inclined at an angle α to the horizontal, where $\alpha \leqslant 45°$ and B is above the plane. The vertical plane defined by APB contains a line of greatest slope of the plane, and PA is inclined at angle 2α to the horizontal (see diagram).

(a) Show that the normal reaction R between A and the plane is $\text{mg}(2\cos\alpha - \sin\alpha)$. [3]

(b) Show that $\text{R} \geqslant \frac{1}{2}mg\sqrt{2}$. [3]

The coefficient of friction between A and the plane is μ. The particle is about to slip down the plane.

(c) Show that $0.5 < \tan\alpha \leqslant 1$. [3]

(d) Express μ as a function of $\tan\alpha$ and deduce its maximum value as α varies. [3]