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**MATHEMATICS**

**9794/03**

Paper 3 Applications of Mathematics

**May/June 2014**

**2 hours**

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

\* 4 5 6 8 0 3 9 7 0 0 \*

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

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.

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

**Section A: Probability (40 marks)**

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

- 1 The masses, in kilograms, of 100 chickens on sale in a large supermarket were recorded as follows.

|                    |                    |                    |                    |                    |                    |
|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Mass ( $x$ kg)     | $1.6 \leq x < 1.8$ | $1.8 \leq x < 2.0$ | $2.0 \leq x < 2.2$ | $2.2 \leq x < 2.4$ | $2.4 \leq x < 2.6$ |
| Number of chickens | 16                 | 27                 | 28                 | 18                 | 11                 |

Calculate estimates of the mean and standard deviation of the masses of these chickens. [5]

- 2  $A$  and  $B$  are two events. You are given that  $P(A) = 0.6$ ,  $P(B) = 0.5$  and  $P(A \cup B) = 0.8$ .

(i) Find  $P(A \cap B)$ . [2]

(ii) Find  $P(B | A)$ . [2]

(iii) Explain whether the events  $A$  and  $B$  are independent or not. [1]

- 3 A discrete random variable  $X$  has the following probability distribution.

|            |     |     |     |     |
|------------|-----|-----|-----|-----|
| $x$        | 1   | 2   | $n$ | 7   |
| $P(X = x)$ | 0.4 | 0.3 | $p$ | 0.1 |

(i) Write down the value of  $p$ . [1]

(ii) Given that  $E(X) = 2.5$ , find  $n$ . [2]

(iii) Find  $\text{Var}(X)$ . [3]

- 4 In a certain country 40% of the population have brown eyes. A random sample of 20 people is chosen from that population.

(i) Find the expected number of people in the sample who have brown eyes. [1]

(ii) Find the probability that there are exactly 8 people with brown eyes in the sample. [3]

(iii) Find the probability that there are at least 8 people with brown eyes in the sample. [2]

- 5 There are 15 students enrolled in a Maths club.

(i) In how many ways is it possible to choose 4 of the students to take part in a competition? [2]

There are 4 different medals to be allocated, at random, to the students in the Maths club.

(ii) If there are no restrictions about how many medals a student may receive, in how many ways can the medals be allocated? [2]

(iii) Find the probability that no student receives more than one medal. [3]

- 6 A machine is being used to manufacture ball bearings. The diameters of the ball bearings are normally distributed with mean 8.3 mm and standard deviation 0.20 mm.
- (i) Find the probability that the diameter of a randomly chosen ball bearing lies between 8.1 mm and 8.5 mm. [5]
- (ii) Following an overhaul of the machine, it is now found that the diameters of 88% of ball bearings are less than 8.5 mm while 10% are less than 8.1 mm. Estimate the new mean and standard deviation of the diameters. [6]

**Section B: Mechanics (40 marks)**

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

- 7 A stone is projected vertically upwards from ground level at a speed of  $30 \text{ m s}^{-1}$ . It is assumed that there is no wind or air resistance. Find the maximum height it reaches and the total time it takes from its projection to its return to ground level. [5]
- 8 A particle is being held in equilibrium by the following set of forces (in newtons).
- $$\mathbf{F}_1 = 5\mathbf{i} - 8\mathbf{j}, \quad \mathbf{F}_2 = -3\mathbf{i} - 4\mathbf{j}, \quad \mathbf{F}_3 = 6\mathbf{i} + 6\mathbf{j} \quad \text{and} \quad \mathbf{F}_4.$$
- (i) Find  $\mathbf{F}_4$  in terms of  $\mathbf{i}$  and  $\mathbf{j}$ . [2]
- (ii) Hence find the magnitude and direction of  $\mathbf{F}_4$ . [4]
- 9 A particle of mass  $m$  is placed on a rough inclined plane. The plane makes an angle  $\theta$  with the horizontal. The coefficient of friction between the particle and the plane is  $\mu$  where  $\mu < \tan \theta$ . The particle is released from rest and accelerates down the plane.
- (i) Draw a fully labelled diagram to show the forces acting on the particle. [1]
- (ii) Find an expression in terms of  $g$ ,  $\theta$  and  $\mu$  for the acceleration of the particle. [5]
- (iii) Explain what would happen to the particle if  $\mu > \tan \theta$ . [1]
- 10 A particle  $P$  is free to move along a straight line  $Ox$ . It starts from rest at  $O$  and after  $t$  seconds its acceleration  $a \text{ m s}^{-2}$  is given by  $a = 12 - 6t$ .
- (i) Find an expression in terms of  $t$  for its velocity  $v \text{ m s}^{-1}$ . Hence find the velocity of  $P$  when  $t = 4$ . [4]
- (ii) Find the displacement of  $P$  from  $O$  when  $t = 4$ . [3]
- (iii) Find the velocity of  $P$  when it returns to  $O$ . [3]

**[Question 11 is printed on the next page.]**

**11** A light inextensible string passes over a smooth fixed pulley. Particles of mass 0.2 kg and 0.3 kg are attached to opposite ends of the string, so that the parts of the string not in contact with the pulley are vertical. The system is released from rest with the string taut.

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

When the heavier particle has fallen 2.25 m it hits the ground and is brought to rest (and the string goes slack).

(ii) Find the speed with which it hits the ground. [2]

(iii) Find the magnitude of the impulse of the ground on the particle. [2]

(iv) If the impact between the particle and the ground lasts for 0.005 seconds, find the constant force that would be needed to bring the particle to rest. [2]