

Please write clearly in block capitals.

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

INTERNATIONAL AS FURTHER MATHEMATICS

(9665/FM02) Unit FPSM1 Pure Mathematics, Statistics and Mechanics

Wednesday 13 January 2021 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

- For this paper you must have the Oxford International AQA Booklet of Formulae and Statistical Tables (enclosed).
- You may use a graphical calculator.

Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- There are three sections to this paper.
- The maximum mark for this paper is 80. There are 40 marks for **Section A**, 20 marks for **Section B** and 20 marks for **Section C**.

Advice

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- Show all necessary working; otherwise marks may be lost.

For Examiner's Use

Question	Mark
1	
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10	
11	
12	
TOTAL	



J A N 2 1 F M 0 2 0 1

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FM02

Section A**Pure Mathematics**

Answer **all** questions in the spaces provided.

- 1** The variables X and Y are related by the equation

$$Y = aX + b \quad \text{where } a \text{ and } b \text{ are constants.}$$

It is given that $X = \frac{x^2}{y}$ and $Y = y^3$ where $x \geq 0$ and $y > 0$

The following pairs of values of x and y were obtained from an experiment.

x	1	2	3	4
y	0.64	1.62	2.23	2.65

- 1 (a)** Complete the table below to show the values of X and Y to one decimal place.

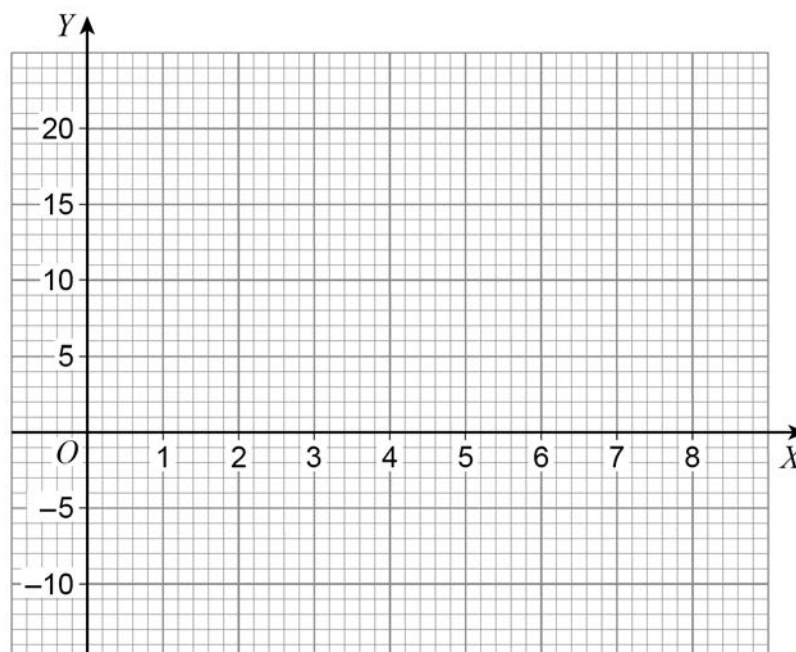
[2 marks]

X				
Y				

- 1 (b)** On the grid below, plot Y against X

Draw a line of best fit for the points you have plotted.

[2 marks]



- 1 (c) (i) Use your line of best fit to find estimates for a and b to one significant figure.

[3 marks]

$a =$ _____ $b =$ _____

- 1 (c) (ii) Using your values of a and b write down an equation relating x and y

[1 mark]

Answer _____

- 1 (d) A student wants to carry out the experiment to obtain $y = 2$

Estimate the value of x the student should use in the experiment, giving your answer to one decimal place.

[2 marks]

Answer _____



2 The matrix **M** is defined by $\mathbf{M} = \begin{bmatrix} m+1 & m-3 \\ -3 & m+2 \end{bmatrix}$ where m is a constant.

The matrix **N** is defined by $\mathbf{N} = \begin{bmatrix} 2 & p \\ 3 & p \end{bmatrix}$ where p is a constant.

2 (a) Find the values of m for which **M** is singular.

[3 marks]

Answer _____

2 (b) In the case when $m = 2$ find the value for p such that

$$\mathbf{MN} = \mathbf{NM}$$

[4 marks]



Answer _____

2 (c) In a different case $p = 2$

2 (c) (i) Calculate the determinant of **N**

[1 mark]

Answer _____

2 (c) (ii) Hence explain the effects of the transformation defined by **N** when applied to a unit square.

[2 marks]



$$\frac{dy}{dx} = \frac{3x+y}{\sqrt{x+y^3}} \quad \text{for } x > 0 \text{ and } y > 0$$

[5 marks]

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Answer

5



4 (a) Show that the equation $f(x) = 0$ has a root α that lies between 3 and 4

Show clearly each step of your working.

[illegible]

Answer

6

5 The matrix \mathbf{T} is defined by $\mathbf{T} = \begin{bmatrix} 9k & 10k \\ -5k & 6 \end{bmatrix}$ where k is a constant.

The point $(1, -1)$ is invariant under the transformation represented by \mathbf{T}

5 (a) Show that $k = -1$

[2 marks]

5 (b) (i) Show that $y = -x$ is a line of invariant points under the transformation represented by \mathbf{T}

[2 marks]



[5 marks]

[illegible]

Answer _____

9

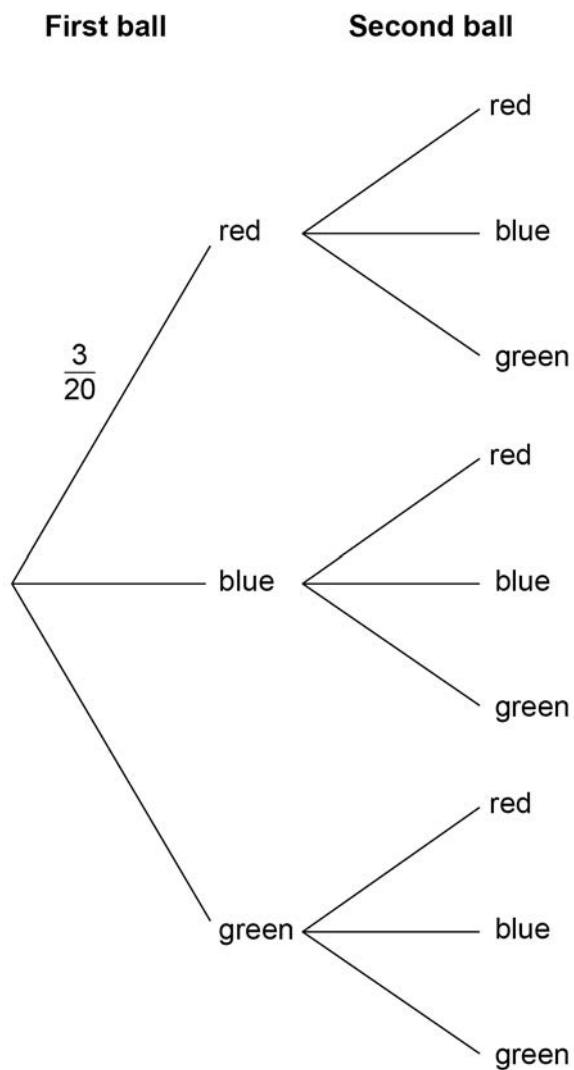
Section B**Statistics**

Answer **all** questions in the spaces provided.

- 6** In a bag there are 3 red balls, 5 blue balls and 12 green balls.
A ball is selected at random from the bag and its colour is recorded.
The ball is **not** replaced in the bag.
A second ball is then selected at random from the bag and its colour is recorded.

- 6 (a)** Complete the tree diagram by writing the probability for each branch.

[2 marks]



- 6 (b)** Find the probability that the first ball selected is green, given that the second ball selected is blue.

[3 marks]

Answer _____

5

Turn over for the next question

Turn over ►



- 7** The discrete random variable X has a uniform distribution and takes the values $1, 2, 3, 4, \dots, n$

The variance of X is 65.25

- 7 (a)** Find the value of n

[2 marks]

Answer _____

- 7 (b)** Find $P(X \geq 4)$

[2 marks]

Answer _____



[3 marks]

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Answer

7

- 8** The discrete random variable X has the following probability distribution where a is a constant.

x	1	2	4	8
$P(X = x)$	0.2	a	0.1	$3a$

- 8 (a)** Find the probability generating function $G_X(t)$

[3 marks]

Answer _____



$$G_Y(t) = \frac{0.35 + 0.65t}{t}$$

By using the probability generating function for $X+Y$, find $E(X+Y)$

[illegible]

8

Mechanics

9 (a) State the dimensions of g , the acceleration due to gravity.

[1 mark]

Answer

9 (b) The equation $T = \frac{2Mmg}{M+m}$ applies to the motion of two connected particles.

T is the force in the string connecting the particles

M and m are the masses of the two particles

g is the acceleration due to gravity

Show that the equation is dimensionally consistent.

[3 marks]

4



[4 marks]

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Answer _____

4

A ball of mass 40 grams is moving at a speed of 8 m s^{-1} on a smooth horizontal surface when it collides with a fixed vertical wall.

The ball is in contact with the wall for 0.1 seconds.

The magnitude of the force, F newtons, exerted by the wall on the ball at time t seconds is modelled by

$$F = ct(0.1 - t) \quad \text{for} \quad 0 \leq t \leq 0.1$$

The ball rebounds with a speed of 4 m s^{-1}

[6 marks]

[illegible]

Answer



[6 marks]

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Answer

END OF QUESTIONS

6



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