Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 Certificate

Tuesday 13 June 2023

Afternoon (Time: 1 hour 40 minutes)

Paper reference **7MC0/02**

Mathematics in Context

PAPER 2: Applications

You must have:
Ruler graduated in centimetres and millimetres, pen, HB pencil, eraser, calculator. Source booklet.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- **Calculators may be used.**

Information

- The total mark for this paper is 80
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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SECTION A

Answer ALL questions. Write your answers in the spaces provided.

FOOTBALL

Refer to **data source A** in the source booklet for Question 1.

1 The table below shows some of the data from Table 1 in the source booklet ordered by net transfer spend.

Team	Final league position	Net transfer spend (£ millions)			
Manchester City	1	191.7			
Manchester United	2	127.0			
Everton	8	84.3			
Chelsea	5	68.1			
Brighton and Hove Albion	15	57.3			
Watford	14	51.6			
West Bromwich Albion	20	44.2			
Huddersfield Town	16	43.5			
Crystal Palace	11	41.7			
AFC Bournemouth	12	29.4			
Leicester City	9	17.9			
Tottenham Hotspur	3	14.8			
Stoke City	19	12.0			
Newcastle United	10	11.5			
Liverpool	4	10.0			
West Ham United	13	−0.3			
Burnley	7	−6.8			
Arsenal	6	−7.6			
Swansea City	18	−30.5			
Southampton	17	−35.5			

(a) (i) Calculate Spearman's rank correlation coefficient for the final league position and net transfer spend.

(5)

(ii) Interpret your answer in context.

(1)

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Spearman's rank correlation coefficient between final league position and total wage bill is 0.765

Amber thinks this means that the total wage bill could have a greater effect than net transfer spend on final league position.

(b) Is Amber correct?
Justify your answer.

(1)

Rahim correctly calculates the product moment correlation coefficient between total wage bill and final league position to be −0.786

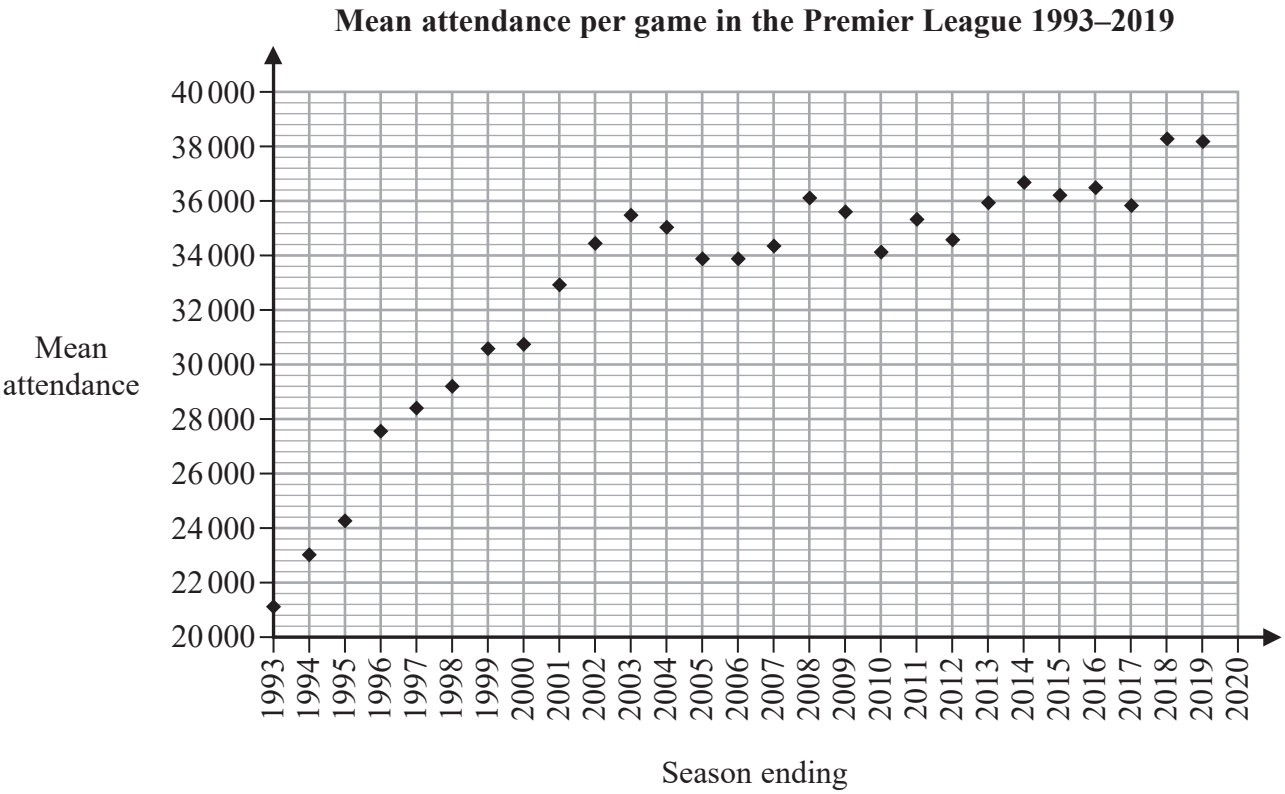
(c) Interpret Rahim's result in context.

(1)

(Total for Question 1 is 8 marks)

Refer to **data source B** in the source booklet for Question 2.

2 The graph below shows the mean attendance per game in the Premier League from the season ending 1993 to the season ending 2019.



Joanne wants to find a model for this data.

(a) Explain why a linear model is not appropriate for this data.

(1)

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Joanne proposes the following model

$$A = 2.9t^3 - 146t^2 + 2490t + c$$

where
A is the mean attendance per game
t = season ending −1993
c is a constant

(b) (i) Use the mean attendance per game for the season ending 1993 given in the source booklet to write down the value of c.

(1)

(ii) Use this model to predict the mean attendance per game for the season ending 2023.

(3)

(iii) Comment on the long-term reliability of the model.

(1)

Joanne proposes a second model

$$A = 40\,400 - B \times 1.09^{-t}$$

where
A is the mean attendance per game
t = season ending −1993
B is a constant

(c) (i) Use the mean attendance per game for the season ending 1993 given in the source booklet to calculate the value of B.

(3)

(ii) Use this model to predict the mean attendance per game for the season ending 2023.

(2)

(iii) State the maximum mean attendance per game predicted by this model.

(1)

(Total for Question 2 is 12 marks)

TOTAL FOR SECTION A IS 20 MARKS

SECTION B

Answer ALL questions. Write your answers in the spaces provided.

TASK 1: MEDICINE

3 A company sells two types of medicine, type A and type B, to pharmacies.

The table below shows the number of each type of medicine a pharmacist ordered in each of two different weeks and the total cost of the orders.

Week	Number of packets of type A ordered	Number of packets of type B ordered	Total cost (£)
1	3	7	12.74
2	2	4	7.60

Work out the cost of one packet of type A medicine and the cost of one packet of type B medicine.

(Total for Question 3 is 4 marks)

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Turn over for Question 4

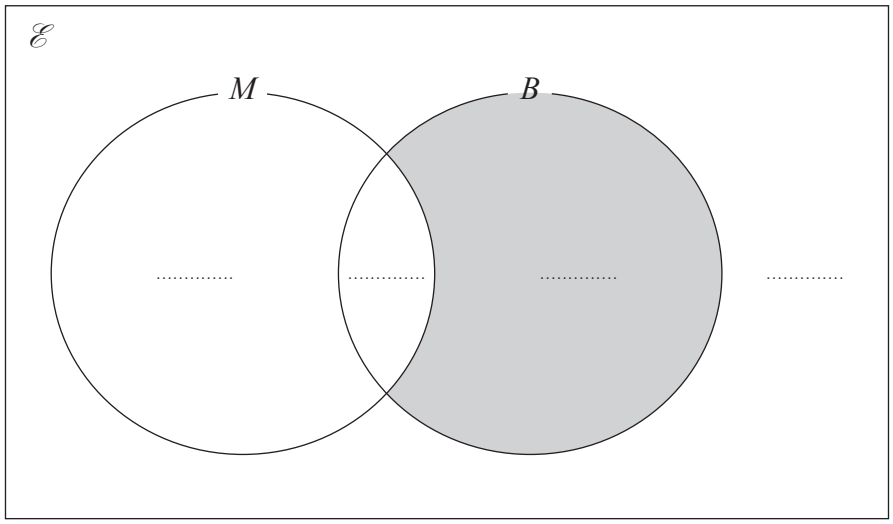
4 A medical company developed a new medicine to reduce blood pressure.
The company carried out a trial to test the medicine.
The company took a sample of 1000 people with high blood pressure.

400 of these people were given the medicine.
600 of these people were not given the medicine.

After the trial

16 of the 400 people given the medicine continued to have high blood pressure.
312 of the 600 people not given the medicine did not have high blood pressure.

The Venn diagram shows the relationship between the sets:
$\mathscr{E}$ = {the 1000 people in the sample}
M = {people given the medicine}
B = {people with high blood pressure after the trial}



(a) Complete the Venn diagram for the information given above.

(3)

(b) (i) Describe, in context, M'

(1)

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(ii) Write, using set notation, the set,

"people in the sample who were given the medicine and did not have high blood pressure after the trial".

(1)

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(iii) Describe, in context, the shaded region in the Venn diagram.

(1)

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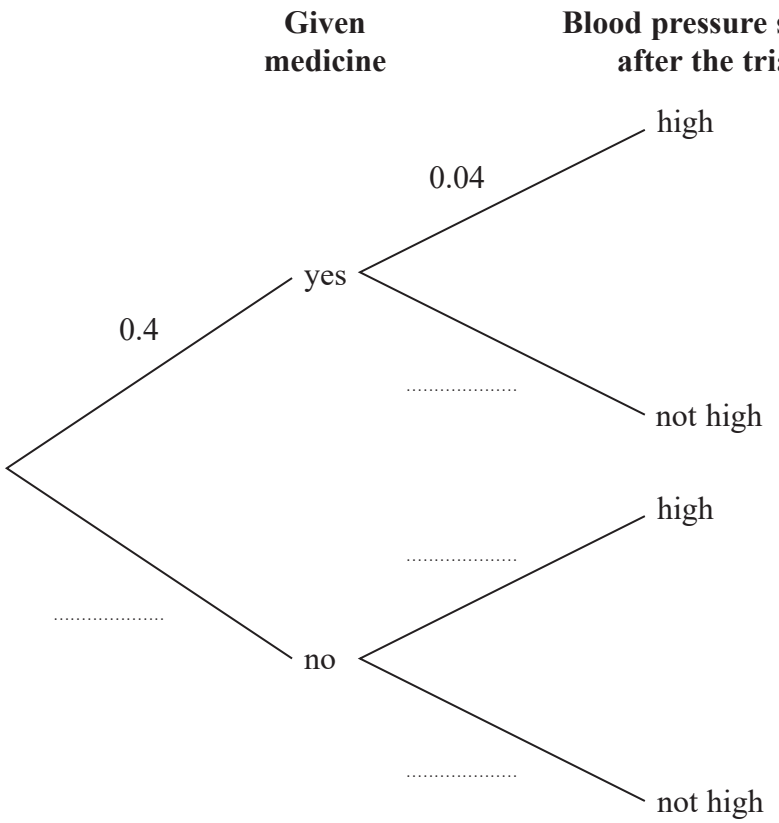
One person is selected at random from the people in the sample.

(c) Complete the probability tree diagram.

(3)



The company claims that a person who has not been given the medicine is 18 times more likely to continue to have high blood pressure after the trial than a person who has been given the medicine.

(d) Assess the company's claim.
You must justify your answer.

(3)

(Total for Question 4 is 12 marks)

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Turn over for Question 5

5 After successful trials the company decides to manufacture and market the medicine.

The manager has two options

- build a small factory for manufacturing
- build a large factory for manufacturing

The table shows the expected profits for each level of sales.

	Expected profit from sales (£ thousands per year)	
	High demand	**Low demand**
Build a small factory	450	400
Build a large factory	1000	100

The cost of building a small factory is £1.3 million.
The cost of building a large factory is £3 million.

The table shows the probability for each level of demand.

	Probability
High demand	0.7
Low demand	0.3

The manager wants to plan for a 5-year period.

Assuming that the level of demand is the same each year, show that the best course of action to maximise profits is to build a small factory.
State the total expected profit for the 5-year period.

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(Total for Question 5 is 4 marks)

TASK 2: CIRCUIT BOARDS

6 A company uses a machine to manufacture circuit boards in a factory.
The ambient temperature is the temperature of the factory where the machine operates.

The table below shows information about how the daily maximum ambient temperature, (T°C), varied over a 30-day period.

Daily maximum ambient temperature (T°C)	Number of days
$0 \leqslant T < 10$	2
$10 \leqslant T < 20$	7
$20 \leqslant T < 25$	10
$25 \leqslant T < 30$	7
$30 \leqslant T < 40$	4

(a) Write down the modal class interval.

(1)

.....

.....

(b) Calculate the frequency density for the class interval $25 \leqslant T < 30$

(1)

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(c) Add an appropriate scale to the vertical axis of the histogram opposite.

(1)

(d) Complete the histogram.

(2)

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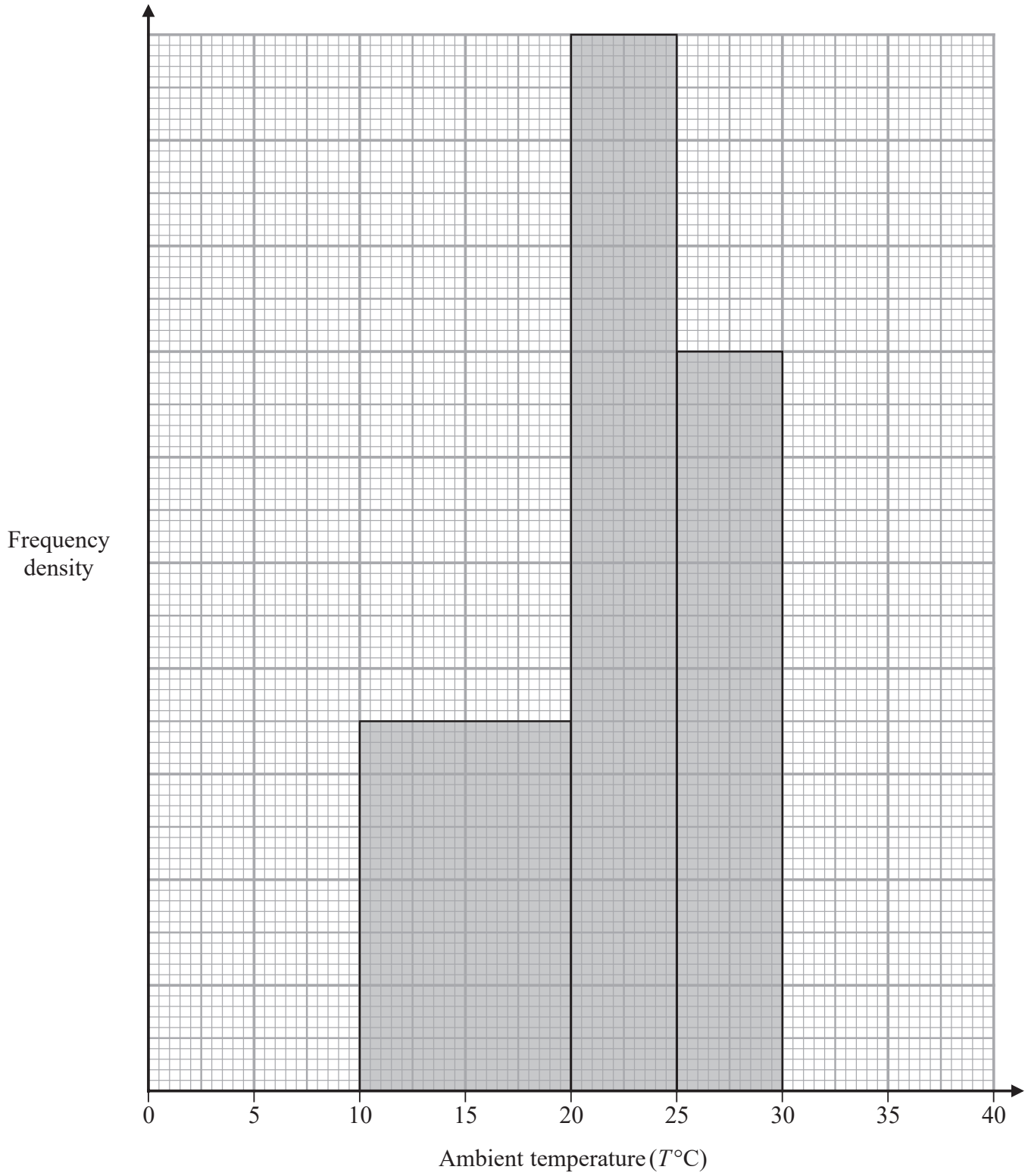

Daily maximum ambient temperature (T°C)	Number of days		
$0 \leqslant T < 10$	2		
$10 \leqslant T < 20$	7		
$20 \leqslant T < 25$	10		
$25 \leqslant T < 30$	7		
$30 \leqslant T < 40$	4		

(e) Calculate an estimate of the mean daily maximum ambient temperature for the 30-day period.

(4)

The standard deviation of the daily maximum ambient temperature for the 30 days is 7.8 °C, correct to one decimal place.

Let $\overline{T}$ = the mean daily maximum ambient temperature

σ = the standard deviation of the daily maximum ambient temperature

A lower bound, L, for the daily maximum ambient temperature is given by,

$$L = \overline{T} - \sigma$$

(f) Calculate the value of L.

(1)

The maximum daily ambient temperature must be above the lower bound for the machine to operate efficiently.

(g) Estimate the number of days that the machine is not operating efficiently.
Show clear working to support your answer.

(3)

(Total for Question 6 is 13 marks)

7 The company makes a profit of £10 million during the year 2021.

Due to falling demand the company expects the profit to decrease by 5% each year.

(a) Calculate the profit the company expects to make during the year 2030.

(2)

(b) Calculate the total expected profit for the 10-year period from 2021 to 2030 inclusive.

(3)

Assuming that the profit continues to decrease by 5% each year,

(c) show that the total expected profit will never be greater than £200 million.

(2)

(Total for Question 7 is 7 marks)

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Turn over for Question 8

TASK 3: CLOTHING

8 A clothing manufacturer makes three types of garment: pairs of jeans, t-shirts and skirts.

Each pair of jeans requires 600 g of cotton.
Each t-shirt requires 200 g of cotton.
Each skirt requires 250 g of cotton.

The manufacturer has 225 kg of cotton available each day.

The number of pairs of jeans made must be **at least** 20% of the total number of garments made.
The number of pairs of jeans made can be **at most** 60% of the total number of garments made.

Let x represent the number of pairs of jeans made each day.
Let y represent the number of t-shirts made each day.
Let z represent the number of skirts made each day.

$$x \geqslant 0, \quad y \geqslant 0 \quad \text{and} \quad z \geqslant 0$$

(a) Write down three further inequalities to represent this information.
Give your answers in a simplified form with integer coefficients.

(5)

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The table shows the profit, in pence, that the manufacturer will make on each type of garment.

Type of garment	Profit (pence)
Pair of jeans	80
T-shirt	50
Skirt	70

The manufacturer wishes to maximise the profit, P pence, made each day.

(b) Write down the objective function, P, in terms of x, y and z.

(1)

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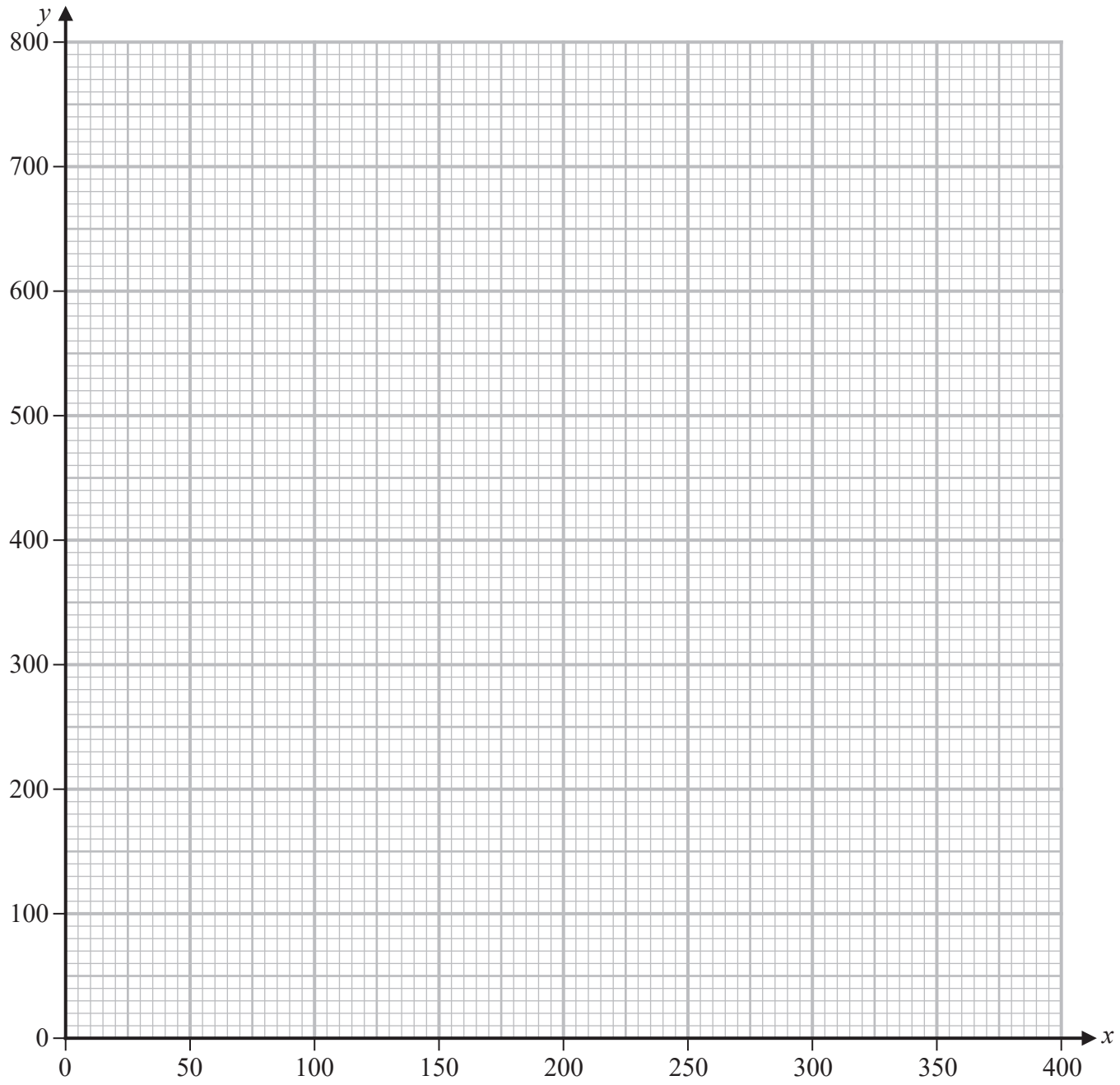
.....

The manufacturer decides to make the same number of t-shirts as skirts.
The constraints from part (a) become:

$$3y \geqslant x$$
$$y \leqslant 2x$$
$$4x + 3y \leqslant 1500$$

(c) Represent these inequalities on the grid below.
Label the feasible region **R**.

(4)



(d) (i) Find the coordinates of the point giving the maximum value of P.
You must make your method clear.

(5)

(ii) Hence, determine the number of each type of garment that the manufacturer should make each day and the total expected maximum daily profit.

(4)

(e) State one assumption that needs to be made in part (d)(ii) in order to make the maximum daily profit.

(1)

(Total for Question 8 is 20 marks)

TOTAL FOR SECTION B IS 60 MARKS
TOTAL FOR PAPER IS 80 MARKS

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Tuesday 13 June 2023

Afternoon (Time: 1 hour 40 minutes)

Paper reference **7MC0/02**

Mathematics in Context

PAPER 2: Applications

Source booklet

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Formulae sheet

There will be no credit for anything you write on this formulae sheet.

Mean of a frequency distribution $= \dfrac{\sum fx}{\sum f}$

Mean of a grouped frequency distribution $= \dfrac{\sum fx}{\sum f}$, where x is the mid-interval value

Variance $= \dfrac{\sum (x - \bar{x})^2}{n}$

Standard deviation (set of numbers) $\sqrt{\left[\dfrac{\sum x^2}{n} - \left(\dfrac{\sum x}{n}\right)^2\right]}$

or $\sqrt{\left[\dfrac{\sum (x - \bar{x})^2}{n}\right]}$

where $\bar{x}$ is the mean of the set of values

Standard deviation

(discrete frequency distribution) $\sqrt{\left[\dfrac{\sum fx^2}{\sum f} - \left(\dfrac{\sum fx}{\sum f}\right)^2\right]}$

or $\sqrt{\left[\dfrac{\sum f(x - \bar{x})^2}{\sum f}\right]}$

Spearman's rank correlation coefficient $1 - \dfrac{6\sum d^2}{n(n^2 - 1)}$

The product moment correlation coefficient is

$$r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}} = \frac{\sum x_i y_i - \frac{\left(\sum x_i\right)\left(\sum y_i\right)}{n}}{\sqrt{\left(\sum x_i^2 - \frac{\left(\sum x_i\right)^2}{n}\right)\left(\sum y_i^2 - \frac{\left(\sum y_i\right)^2}{n}\right)}}$$

The regression coefficient of y on x is $b = \frac{S_{xy}}{S_{xx}}$

Least squares regression line of y on x is $y = a + bx$ where $a = \bar{y} - b\bar{x}$

Arithmetic series

$$u_n = a + (n - 1)d$$

$$S_n = \frac{1}{2}n(a + l) = \frac{1}{2}n[2a + (n - 1)d]$$

Geometric series

$$u_n = ar^{n-1}$$

$$S_n = \frac{a(1 - r^n)}{1 - r}$$

$$S_\infty = \frac{a}{1 - r} \quad \text{for} \quad |r| < 1$$

There will be no credit for anything you write in this source booklet.

SECTION A: FOOTBALL

Data source A

Some information is shown about the teams in the Premier League for the season 2017–18
The total wage bill is the total amount paid to the players of each team.
The net transfer spend is the amount each team spent on incoming players minus the amount received for outgoing players.

Table 1: Premier League Table 2017–18 season

Final league position	Team	Total wage bill (£millions)	Net transfer spend (£millions)
1	Manchester City	260	191.7
2	Manchester United	296	127.0
3	Tottenham Hotspur	148	14.8
4	Liverpool	264	10.0
5	Chelsea	246	68.1
6	Arsenal	240	−7.6
7	Burnley	82	−6.8
8	Everton	145	84.3
9	Leicester City	119	17.9
10	Newcastle United	94	11.5
11	Crystal Palace	117	41.7
12	AFC Bournemouth	102	29.4
13	West Ham United	107	−0.3
14	Watford	86	51.6
15	Brighton and Hove Albion	78	57.3
16	Huddersfield Town	63	43.5
17	Southampton	113	−35.5
18	Swansea City	91	−30.5
19	Stoke City	94	12.0
20	West Bromwich Albion	92	44.2

Data source B

Table 2: Mean attendance per game in the Premier League for seasons ending 1993–2019

Season ending	Mean attendance
1993	21 125
1994	23 040
1995	24 271
1996	27 550
1997	28 434
1998	29 190
1999	30 581
2000	30 757
2001	32 907

Season ending	Mean attendance
2002	34 448
2003	35 464
2004	35 020
2005	33 890
2006	33 864
2007	34 363
2008	36 076
2009	35 609
2010	34 151

Season ending	Mean attendance
2011	35 294
2012	34 599
2013	35 921
2014	36 670
2015	36 179
2016	36 461
2017	35 809
2018	38 310
2019	38 181

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Source information

Data source A adapted from:
https://www.planetfootball.com/quick-reads/how-every-every-pl-and-champ-clubs-wages-compare-to-their-league-finish/

Data source B:

https://www.european-football-statistics.co.uk/attn/nav/attnengleague.htm