OCR
Oxford Cambridge and RSA

Tuesday 17 June 2025 – Afternoon

Level 3 Free Standing Mathematics Qualification: Additional Mathematics

6993/01 Paper 1

Time allowed: 2 hours

You must have:
- the Formulae Sheet for Level 3 Free Standing Mathematics Qualification: Additional Mathematics (inside this document)

You can use:
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined page at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- Give your final answers to a degree of accuracy that is appropriate to the context.

INFORMATION
- The total mark for this paper is **100**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

Formulae
FSMQ Additional Mathematics (6993)

Binomial series

$(a+b)^n = a^n + {}^n\mathrm{C}_1 a^{n-1}b + {}^n\mathrm{C}_2 a^{n-2}b^2 + \ldots + {}^n\mathrm{C}_r a^{n-r}b^r + \ldots + b^n$, for positive integers, n,

where ${}^n\mathrm{C}_r = {}_n\mathrm{C}_r = \binom{n}{r} = \frac{n!}{r!(n-r)!}$, $r \leqslant n$

The binomial distribution

If $X \sim B(n, p)$ then $P(X = x) = \binom{n}{x} p^x (1-p)^{n-x}$

Numerical methods

Trapezium rule: $\int_a^b y \, \mathrm{d}x \approx \frac{1}{2}h\{(y_0 + y_n) + 2(y_1 + y_2 + \ldots + y_{n-1})\}$, where $h = \frac{b-a}{n}$

Kinematics

Variable acceleration formulae

$v = \frac{\mathrm{d}s}{\mathrm{d}t}$

$a = \frac{\mathrm{d}v}{\mathrm{d}t} = \frac{\mathrm{d}^2 s}{\mathrm{d}t^2}$

$s = \int v \, \mathrm{d}t$ and $v = \int a \, \mathrm{d}t$

Constant acceleration formulae

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$s = \frac{1}{2}(u+v)t$

$v^2 = u^2 + 2as$

$s = vt - \frac{1}{2}at^2$

1 Find the coefficient of x^3 in the expansion of $(2-3x)^5$. **[3]**

1	

2 **In this question you must show detailed reasoning.**

Solve the inequality $7 < 3(x-2)+1 < 16$. **[3]**

2	

3 Determine the exact value of $x^2 - x + 5$ when $x = 3 + \sqrt{2}$. **[3]**

3	

4 Determine the equation of the tangent to the curve $y = 4 + x + x^2$ at the point (1, 6). **[4]**

4	

5 **(a)** On the grid below, indicate the region for which the following inequalities hold. You should shade the region that is **not** satisfied by the inequalities.

$2x + 3y \leqslant 12$

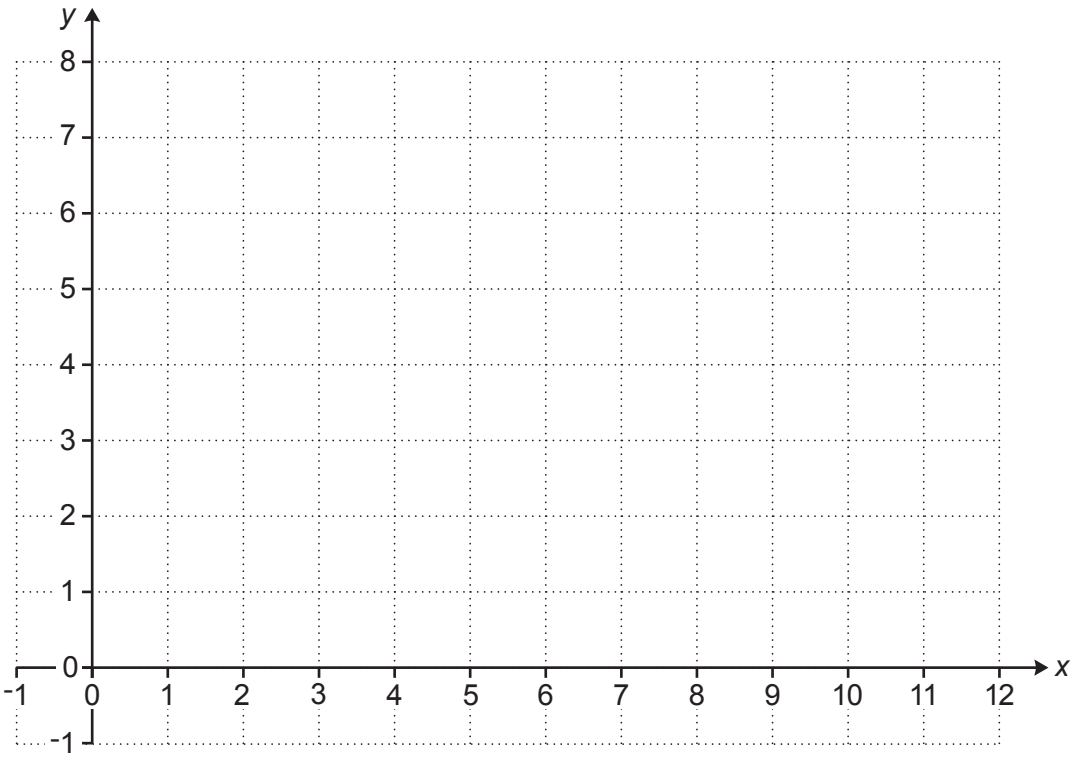
$x + 3y \geqslant 9$

$x \geqslant 0$

[4]

(b) Write down the minimum value of $2x + y$ within this region. **[1]**

5(a)



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5(b)

6 A car accelerates from rest in a straight line. At time t seconds the displacement of the car, s metres, is modelled by the equation

$$s = \frac{t^3}{2} - \frac{t^4}{24}.$$

(a) Determine the maximum velocity of the car. **[6]**

(b) Describe what is happening when $t \geqslant 9$. **[2]**

6(a)

6(b)

7 A small club consists of 10 members.

(a) In how many ways can 4 members be chosen from the 10 members? **[2]**

(b) You are given that half of the members are male and half are female.

In how many ways can 4 members be chosen so that

(i) they are either all male or all female, **[2]**

(ii) 2 are male and 2 are female? **[2]**

7(a)	
7(b)(i)	
7(b)(ii)	

8 In this question you must show detailed reasoning.

(a) Solve the simultaneous equations $y = 2x^2 - 5x + 4$ and $x + y = 2$. **[4]**

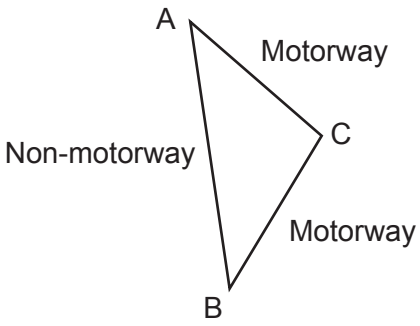
(b) State the geometrical relationship between the graphs of $y = 2x^2 - 5x + 4$ and $x + y = 2$. **[1]**

8(a)

8(b)

9 Tom plans to travel by car from a point A to a point B. There are two routes that he can take. He can take either a motorway route or a non-motorway route.
Tom models the roads used on these two routes as straight lines. The line AB represents the non-motorway route. The lines AC and CB represent the two motorways used for the motorway route.

The diagram illustrates the two routes where C is the junction of the motorways.



Not to scale

You are given that AC = 50 km, CB = 40 km and angle ACB = 120°.

(a) Calculate the distance AB. **[3]**

9(a)	

In his model Tom assumes that:
- he drives at a constant speed
- he can move through the junction at C without losing speed
- his speed on the non-motorway route is kv where v is his speed on the motorway route, k is a constant and $k < 1$.

(b) Determine the value of k such that the time taken to travel each route is the same. **[3]**

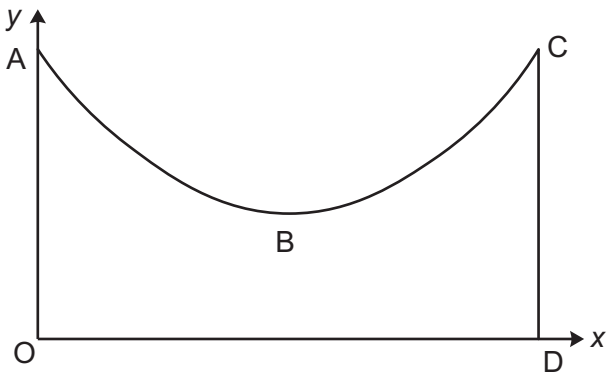
9(b)	

10 In this question you must show detailed reasoning.

Solve the equation $\frac{1}{x-5}-\frac{1}{x}+\frac{5}{6}=0$. **[5]**

10

11 A rectangular metal plate OACD is aligned on a coordinate system such that O is the origin and A, C and D have coordinates (0, 16), (6, 16) and (6, 0) respectively.
A curved section ABC is removed from OACD to leave the shape OABCD shown in the diagram.
The curved edge ABC has equation $y = x^2 - 6x + 16$ and B is the stationary point on the curve.



(a) By completing the square, determine the coordinates of B. **[3]**

(b) The line $y = k$ is such that it cuts the **area** of the shape OABCD in half.

Find the value of k. **[5]**

11(a)	
11(b)	

12 Heidi and Charlie have been asked to solve the equation $f(x) = 1.3^x - x = 0$.

(a) Show by sign change that $f(x) = 0$ has a root, α, in the interval [1,2]. **[2]**

(b) Heidi attempts to solve the equation $f(x) = 0$ using the iterative formula $x_{r+1} = \dfrac{\log_{10} x_r}{\log_{10} 1.3}$.

She starts with $x_0 = 1.4$. Show that the sequence derived from this iterative formula fails to find α. **[2]**

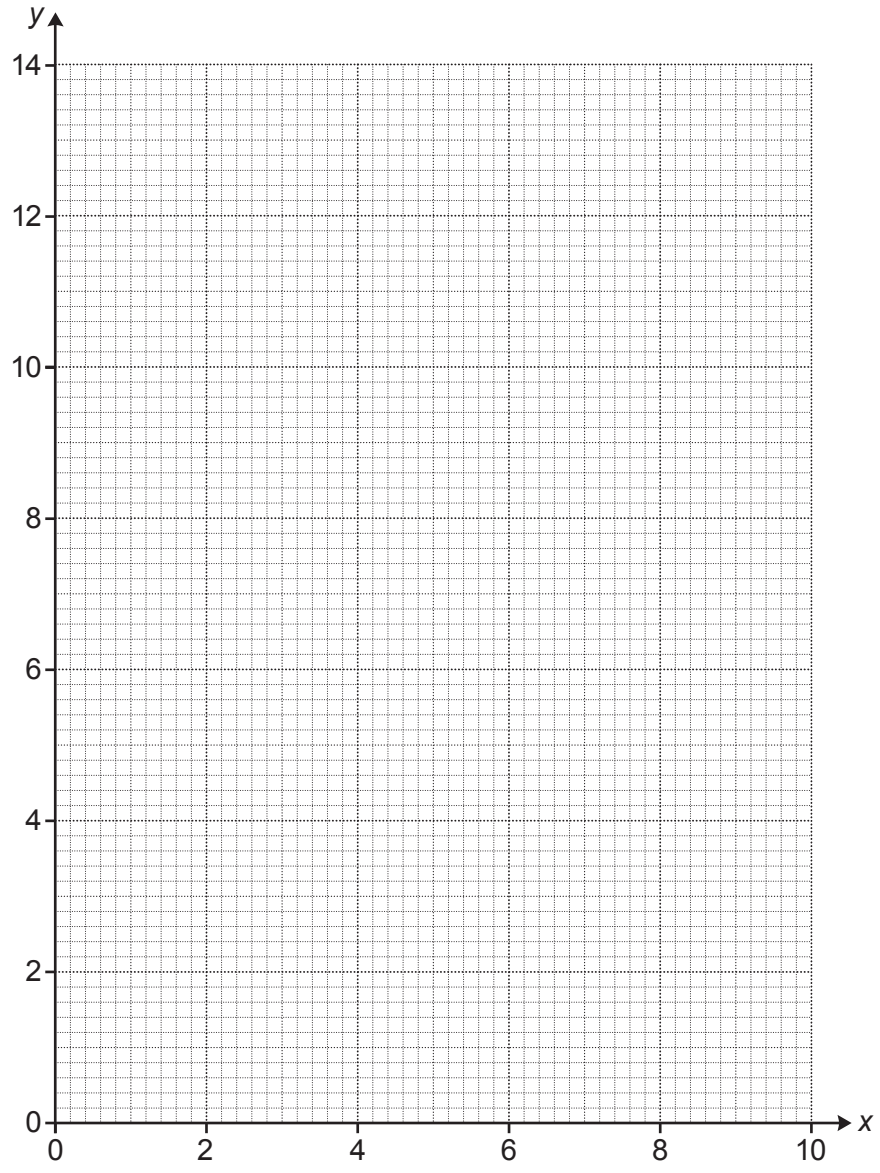
(c) Charlie attempts to solve the equation $f(x) = 0$ using the iterative formula $x_{r+1} = 1.3^{x_r}$.
Starting with $x_0 = 1.4$, determine the value of α correct to **3** significant figures. **[3]**

12(a)	
12(b)	
12(c)	

(d) (i) Plot both the curve $y = 1.3^x$ and the line $y = x$ on the grid below to show that there is another root, β, which you should identify on your graph. **[4]**

(ii) Give the integer interval within which β lies. **[1]**

12(d)(i)



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12(d)(ii)

(e) Without doing any further calculation, use your graph to explain why Charlie will not find β using his iterative formula. **[2]**

12(e)	

13 **(a)** You are given that $\sin 2\theta = 0.7$.

Find the values of θ for $0° \leqslant \theta \leqslant 360°$.
Give your answers correct to **1** decimal place. **[3]**

(b) Given that $0° < \theta < 90°$, show that $\dfrac{1}{\sin^2\theta} - \dfrac{1}{\tan^2\theta} \equiv 1$. **[3]**

13(a)	
13(b)	

14 A tower AB stands vertically at a point A. C is a point due south of A and on the same horizontal level. The distance AC is 55 m. From C the angle of elevation of B is 36°.

D is a point due west of the tower and 15 m higher than A and C. The horizontal distance of D from the tower is 35 m.

Find the angle of elevation of B from D. **[5]**

14

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15 The table shows population data for a country. t is the number of years after 1920.

Years after 1920 (t)	0	20	40	60	80	100
Population in millions (p)	20	31.7	51.3	79.6	126.2	200

Jane believes that this population growth may be modelled by the equation $p = c \times 10^{kt}$ where c and k are constants.

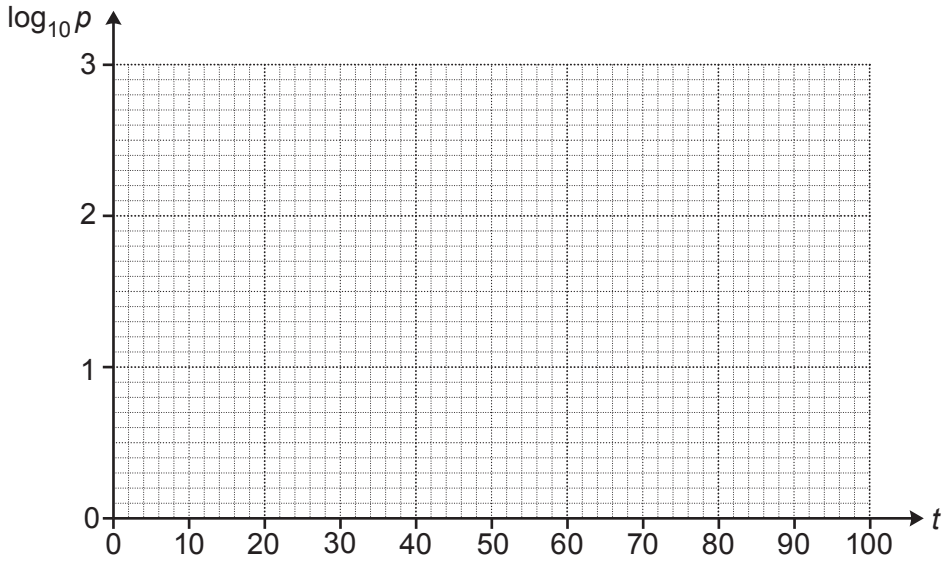
(a) Derive an equation for $\log_{10} p$ in terms of c, k and t. **[3]**

(b) Plot the points $(t, \log_{10} p)$ for the 6 values of t on the grid.
(You may use the blank row in the table above for your values of $\log_{10} p$.) **[3]**

(c) On the grid draw a line of best fit. **[1]**

15(a)

15(b)
15(c)



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(d) **(i)** State the value of c. **[1]**

(ii) Using your line, or otherwise, estimate a value for k. **[1]**

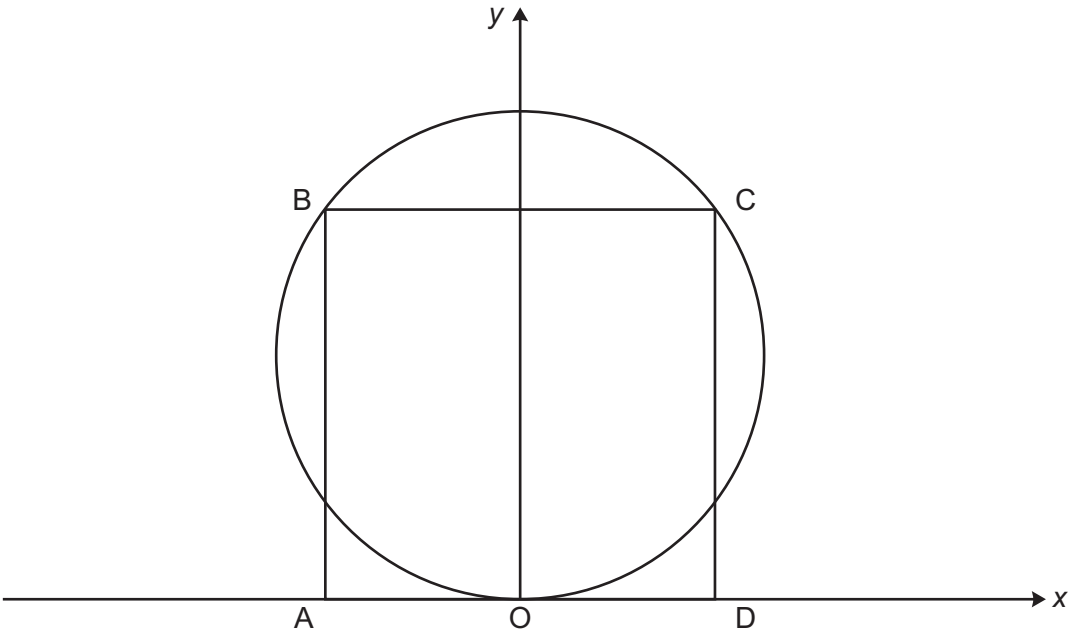
(e) According to the model what will be the population in 2040? **[2]**

(f) Give a reason why this model may **not** be realistic in the long term. **[1]**

15(d)(i)	
15(d)(ii)	
15(e)	
15(f)	

16 A square with vertices ABCD is aligned in a coordinate system where the coordinates of A, B, C and D are (−8, 0), (−8, 16), (8, 16) and (8, 0) respectively.
The origin, O, is the midpoint of AD.

A circle is such that it passes through the points B and C and touches the line AD at the origin as shown in the diagram.



Find

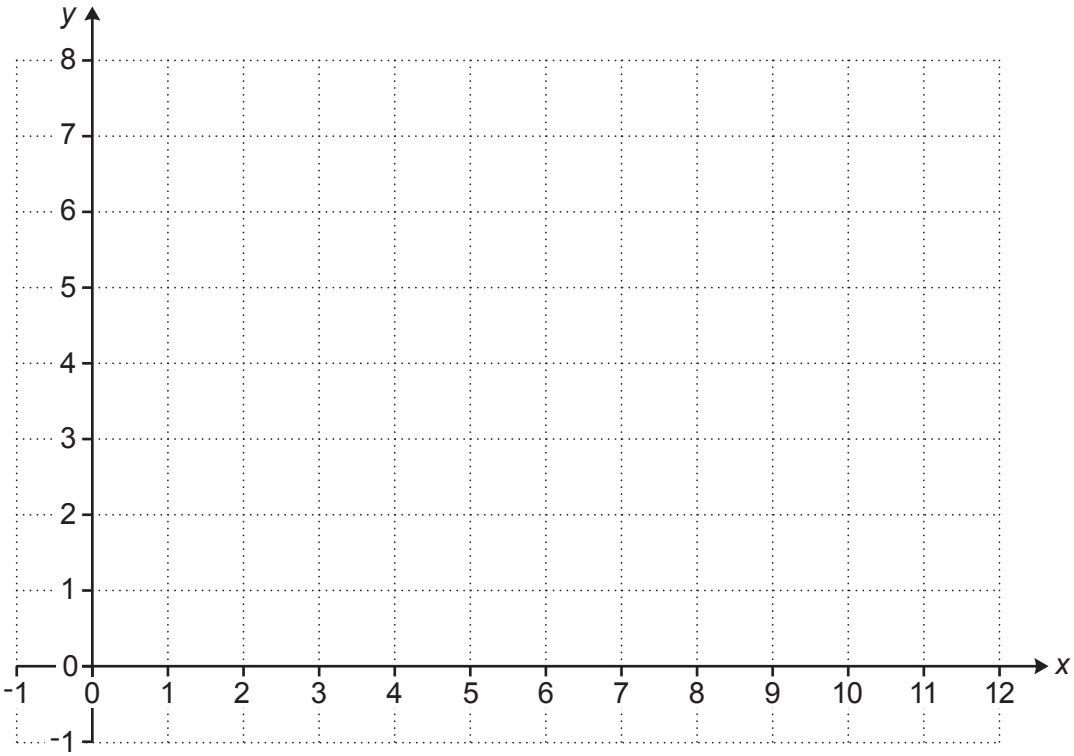
(a) the radius of the circle, **[4]**

(b) the equation of the circle. **[3]**

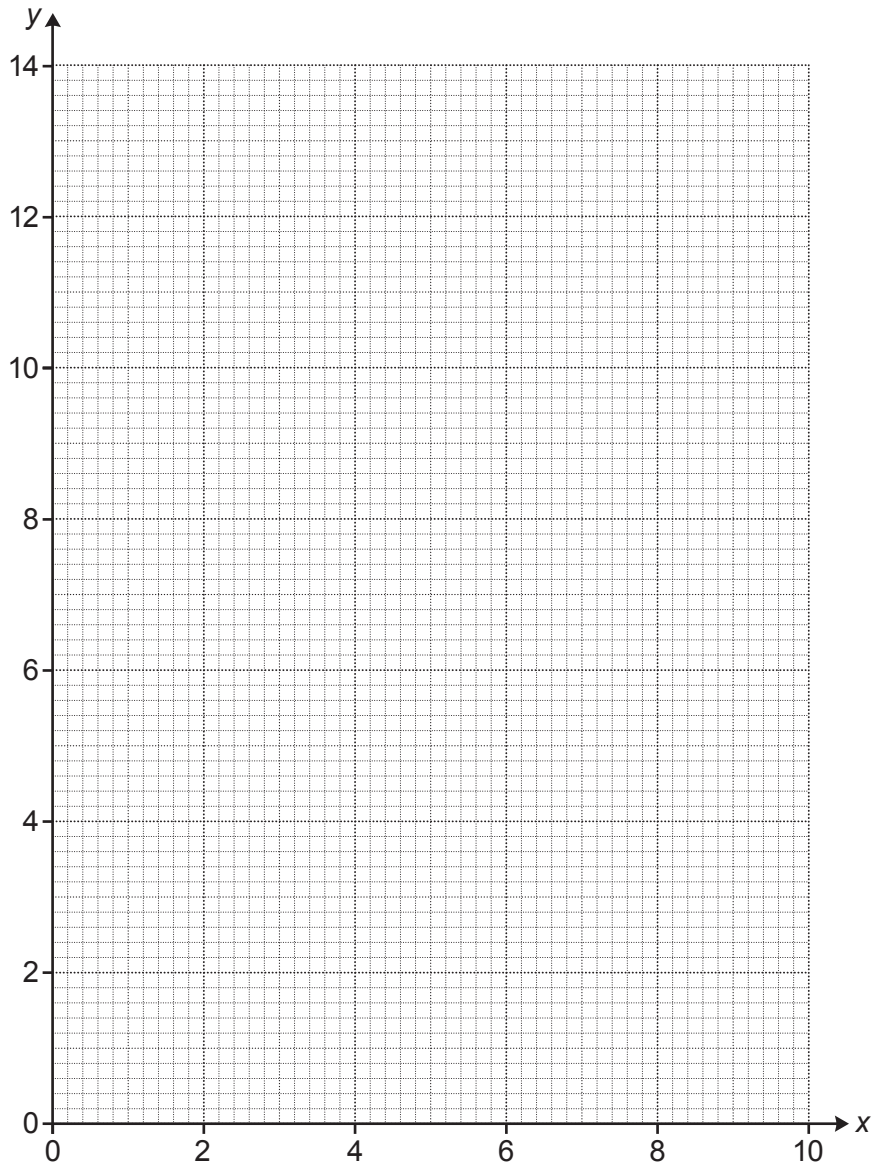
16(a)	
16(b)	

END OF QUESTION PAPER

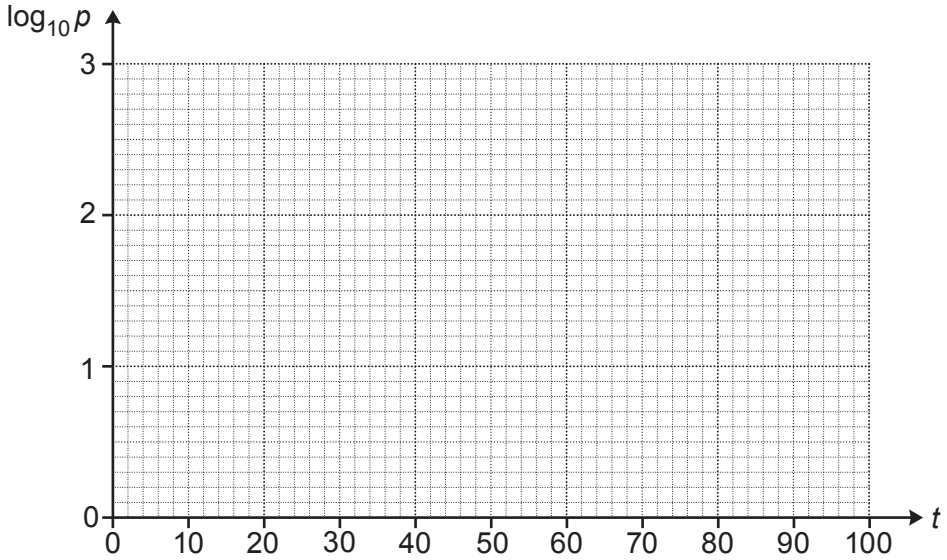
5(a) *This is a spare copy of the grid for question **5(a)**. Only write on this page if you want to offer a second attempt at the graph.*
If you do so, then you must cross through the first attempt on page 5.



12(d)(i) *This is a spare copy of the grid for question **12(d)(i)**. Only write on this page if you want to offer a second attempt at the graph.*
If you do so, then you must cross through the first attempt on page 13.



15(b) *This is a spare copy of the grid for question **15(b)** and **15(c)**. Only write on this page if*
15(c) *you want to offer a second attempt at the graph.*
If you do so, then you must cross through the first attempt on page 18.



EXTRA ANSWER SPACE

If you need extra space use this lined page. You must write the question numbers clearly in the margin.