OCR
Oxford Cambridge and RSA

Regulated

Level 3 Free Standing Mathematics Qualification: Additional Maths

6993 Paper 1

Sample Question Paper

Date – Morning/Afternoon

Time allowed: 2 hours

You may use:
- Scientific or graphical calculator

First name									
Last name									
Centre number						**Candidate number**			

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Read each question carefully before you start to write your answer.
- Write your answer to each question in the space provided.
- Where appropriate, your answer should be supported with working.
- Additional paper may be used if necessary, but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION
- The total mark for this paper is **100**.
- The marks for each question or part question are shown in brackets **[ ]**.
- You are reminded of the need for the clear presentation in your answers.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The Question Paper consists of **20** pages.

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Formulae
FSMQ Additional Maths (6993)

Binomial series

$(a+b)^n = a^n + {}^nC_1\, a^{n-1}b + {}^nC_2\, a^{n-2}b^2 + \ldots + {}^nC_r\, a^{n-r}b^r + \ldots + b^n$, for positive integers, n,

where ${}^nC_r = {}_nC_r = \binom{n}{r} = \frac{n!}{r!(n-r)!}$, $r \leq n$

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

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

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

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

Constant acceleration formulae

$v = u + at$

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

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

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

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

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Answer all questions

1 A sequence is defined by the rule $u_{n+1} = 2u_n - 1$.

Determine the value of u_6 given that $u_3 = 12$. **[2]**

1	

2 Find the coefficient of x^3 in the expansion of $(2+3x)^5$, giving your answer as simply as possible. **[4]**

2	

3 You are given that $y = x^3 + 2x - 7$.

(a) Find $\frac{dy}{dx}$. **[2]**

(b) Use your result to part **(a)** to show that the graph of $y = x^3 + 2x - 7$ has no turning points.

[2]

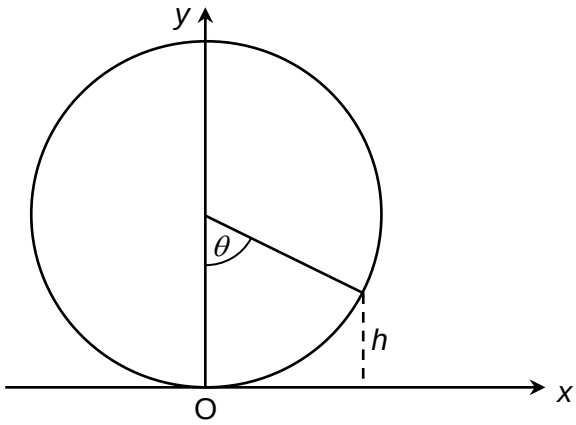
3(a)	
3(b)	

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

Find the value of $\int_1^2 (x^2 + 3)\, dx$. **[4]**

4	

5



The 'London Eye' can be considered to be a circular frame of radius 67.5 m, on the circumference of which are 'capsules' carrying a number of people round the circle. Take a coordinate system where O is the base of the circle and O*y* is a diameter. At any time after starting off round the frame, the capsule will be at height *h* metres when it has rotated $\theta°$.

(a) Sketch a graph of *h* against θ. **[2]**

(b) Give an expression for *h* in terms of θ. **[2]**

(c) Find values of θ when *h* = 100. **[3]**

5(a)	
5(b)	
5(c)	

6 **(a)** Simplify $\frac{x}{x+2} - \frac{6}{x-1}$. **[3]**

In this question you must show detailed reasoning.

(b) Solve $\frac{x}{x+2} - \frac{6}{x-1} = 4$ giving your answer in exact form. **[4]**

6(a)	
6(b)	

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

(a) Express $2x^2 + 8x - 12$ in the form $a(x + p)^2 + q$. **[4]**

(b) Hence find the minimum value of $2x^2 + 8x - 12$. **[1]**

7(a)	
7(b)	

8 A triangle ABC is such that AB = 5 cm, BC = 8 cm and CA = 7 cm.

Show that one angle is 60°. **[4]**

8	

9 In this question you must show detailed reasoning.

(a) Show that $(x-3)$ is a factor of x^3-5x^2+x+15. **[1]**

(b) Hence solve the equation $x^3-5x^2+x+15=0$. **[4]**

9(a)	
9(b)	

10 A security keypad uses three letters A, B and C and four digits 1-4.

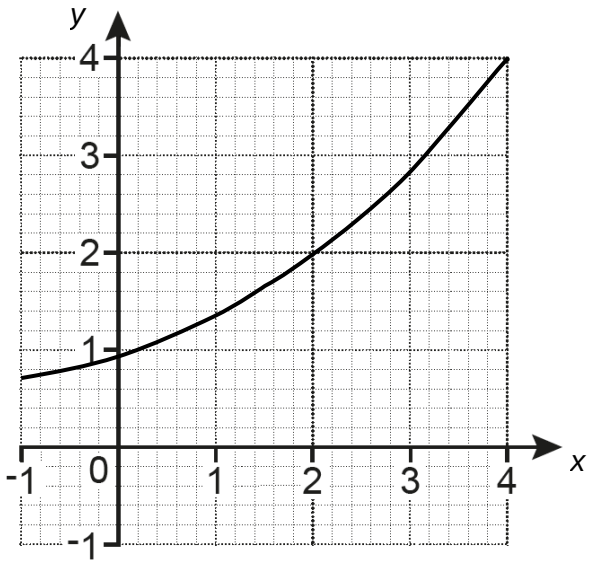
A passcode is created using four inputs.

(a) If there are no restrictions, how many different passcodes are possible? **[1]**

(b) If there must be exactly two letters and two digits, with no repeats, how many different passcodes are possible? **[3]**

10(a)	
10(b)	

11



The graph shows the curve $y = \sqrt{2^x}$.

(a) Use the trapezium rule with two strips to estimate the area enclosed by the curve, the x-axis, $x = 2$ and $x = 4$, stating if this is an over or under estimation. **[4]**

(b) **(i)** Use the chord from (2,2) to (4,4) to estimate the gradient of $y = \sqrt{2^x}$ at $x = 3$. **[1]**

(ii) Determine an estimate for the gradient of the curve $y = \sqrt{2^x}$ at $x = 3$ which is an improvement of the estimate found in part **(b)(i)**. **[2]**

11(a)	

11(b)(i)	
11(b)(ii)	

12 China cups are packed in boxes of 10. It is known that 1 in 8 are cracked.

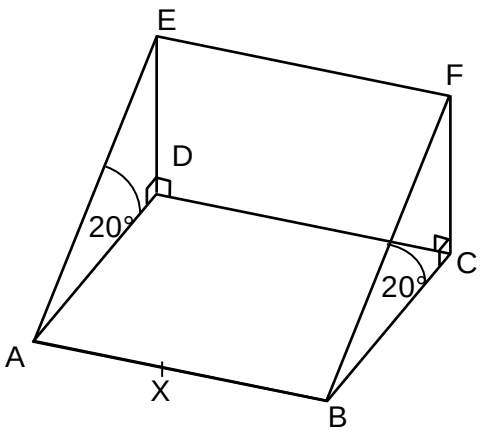
Find the probability that in a box of 10, chosen at random,

(a) exactly 1 cup is cracked, **[3]**

(b) at least 2 cups are cracked. **[4]**

12(a)	
12(b)	

13



The diagram shows a triangular prism.
The rectangle ABCD is horizontal and ABFE is a square inclined at 20° to the horizontal such that E is vertically above D and F is vertically above C.
The area of the square ABFE is 1600 m^2.
X is a point on AB such that AX = 12 m.

Calculate

(a) the area of ABCD, **[3]**

(b) the angle between the lines XE and XF. **[5]**

13(a)	
13(b)	

14 An object is falling through a liquid. The distance fallen is modelled by the formula $s = 48t - t^3$ until it comes to rest, where s is the distance fallen in centimetres and t is the time in seconds measured from the point when the object entered the liquid.

(a) Find

(i) the acceleration when $t = 1$, **[5]**

(ii) the time when the object comes to rest, **[2]**

(iii) the distance fallen when the object comes to rest. **[2]**

(b) Sketch the velocity/time graph for the period of time until the object comes to rest. **[1]**

14(a)(i)	
14(a)(ii)	

14(a)(iii)	
14(b)	

15 John bought a car in January 2015 for £28 000.
He investigated how the value of his car might depreciate over the years. He searched the internet and found the following data.

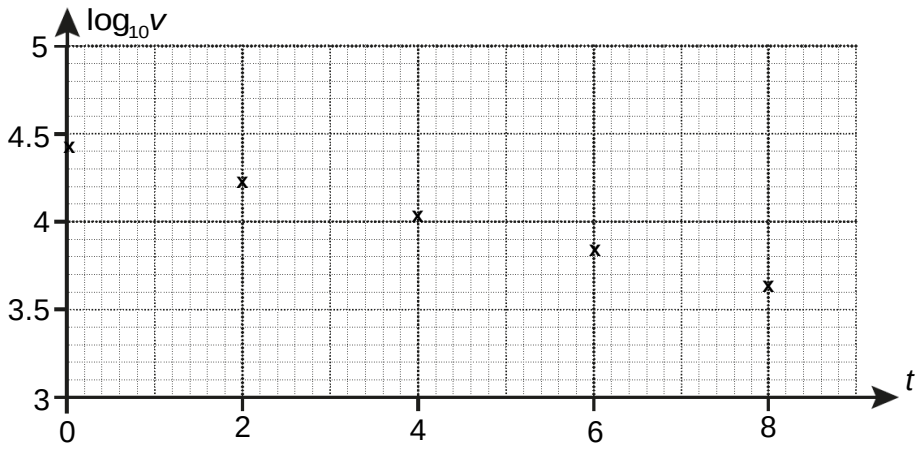
Number of years after buying car (t years)	0	2	4	6	8
Value (£v)	28 000	18 000	11 500	7350	4700

He believes that the relationship between the age of the car and its value can be modelled by the equation $v = ka^t$ where v is the value in pounds and t is the age in years.

(a) Write down the value of k. **[1]**

(b) Show that the equation can be rewritten in the form $\log v = \log k + t \log a$. **[2]**

John plotted $\log_{10} v$ against t and obtained the following graph.



(c) Use the graph above to estimate a value for a. **[3]**

(d) Use this model to estimate the age of John's car when its value drops below £3000. **[3]**

15(a)	

15(b)	
15(c)	
15(d)	

16 A bicycle factory produces two models of bicycle, A and B.
Model A requires 20 hours of unskilled and 10 hours of skilled labour.
Model B requires 15 hours of unskilled and 25 hours of skilled labour.
The factory employs 10 unskilled and 8 skilled labourers, each of whom work a 40 hour week.

(a) Suppose the factory makes x model A and y model B per week.

(i) Show that the restriction of unskilled labour results in the inequality $4x + 3y \leq 80$. **[3]**

(ii) Find a similar inequality from the restriction on skilled labour. **[2]**

(b) Draw graphs for the two inequalities and shade the feasible region. **[3]**

(c) Show that making 15 model A bicycles and 5 model B bicycles is possible. **[1]**

(d) The factory makes a profit of £40 on model A and £60 on model B.

(i) Write down the objective function. **[1]**

(ii) Find the number of each that should be made to maximise the profit. **[3]**

16(a)(i)	
16(a)(ii)	

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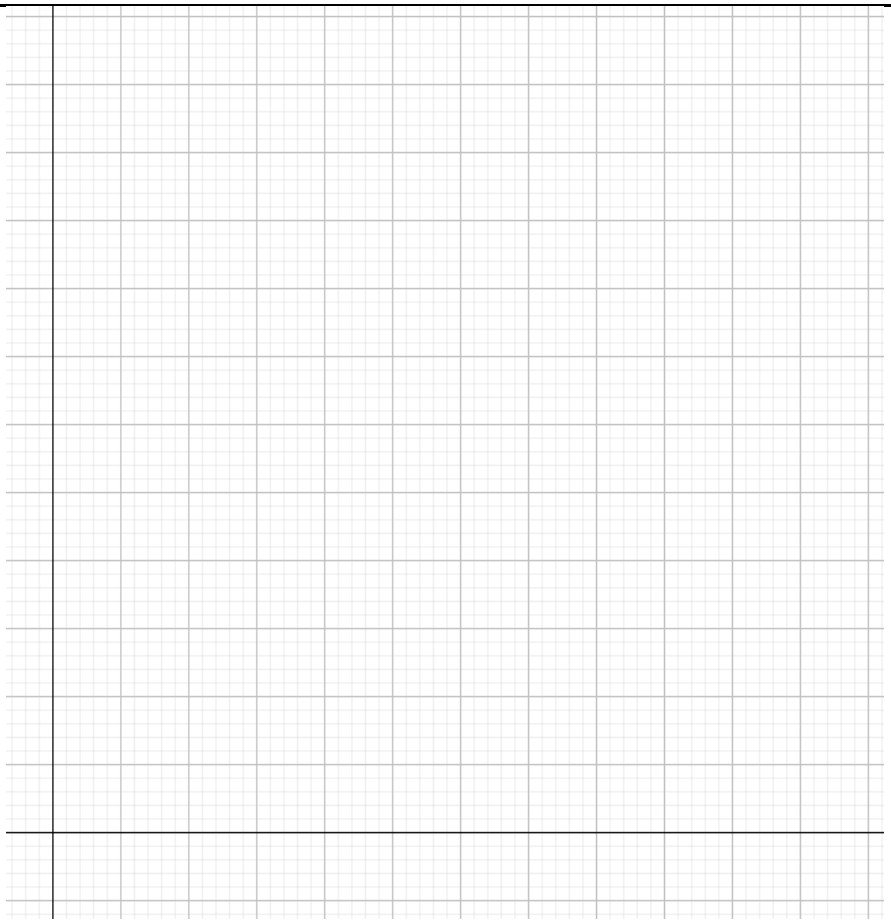
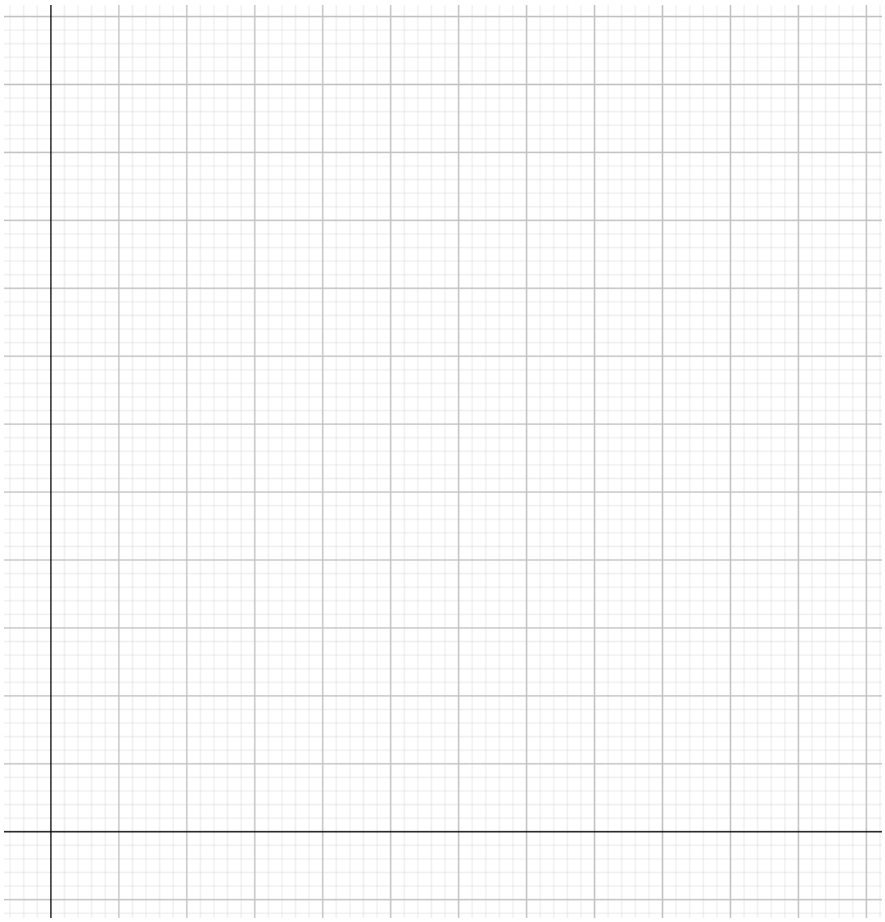
16(b)	 *There is a spare copy of this graph on page 20. If you wish to offer a second attempt, then you must cross through the attempt on this page.*
16(c)	
16(d)(i)	
16(d)(ii)	

16(b)	*This is a spare copy of the graph for question **16(b)**. 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 19.* 

END OF QUESTION PAPER

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