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Centre number	Candidate number	
Surname		-
Forename(s)		-
Candidate signature	I declare this is my own work.	_/

A-level **MATHEMATICS**

Paper 3

Friday 12 June 2020

Afternoon

Time allowed: 2 hours

Materials

- You must have the AQA Formulae for A-level Mathematics booklet.
- You should have a graphical or scientific calculator that meets the requirements of the specification.

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 each question in the space provided for that question.
 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).
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.

Advice

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- You do not necessarily need to use all the space provided.

For Examiner's Use		
Question	Mark	
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Section A

Answer all questions in the spaces provided.

1 Given that

$$\int_0^{10} f(x) \, \mathrm{d}x = 7$$

deduce the value of

$$\int_0^{10} \left(f(x) + 1 \right) dx$$

Circle your answer.

[1 mark]

-3

7

8

17

2 Given that

$$6\cos\theta + 8\sin\theta \equiv R\cos(\theta + \alpha)$$

find the value of R.

Circle your answer.

[1 mark]

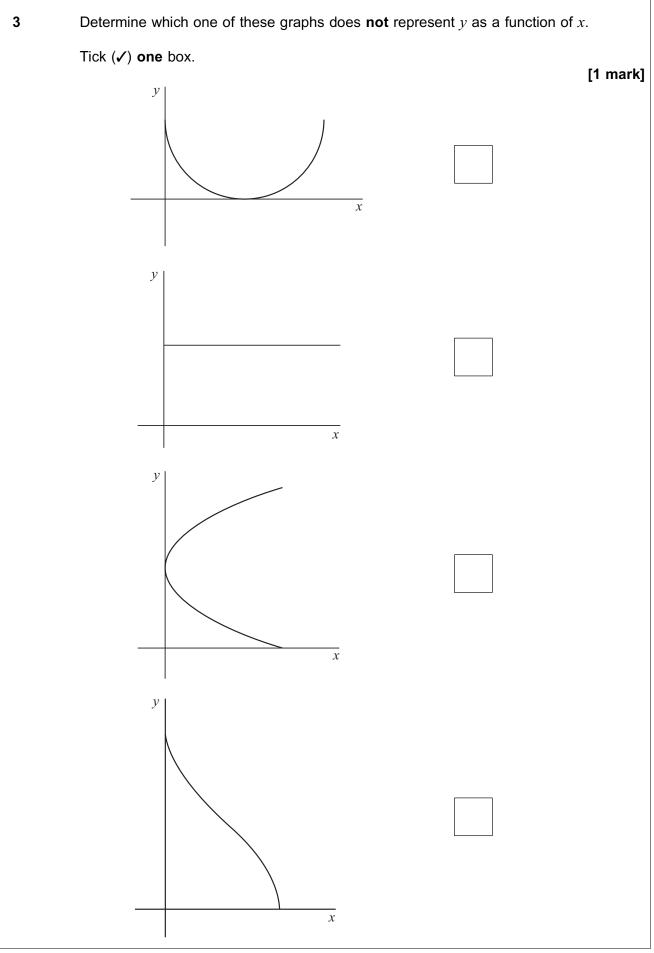
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4	$p(x) = 4x^3 - 15x^2 - 48x - 36$	
4 (a)	Use the factor theorem to prove that $x - 6$ is a factor of $p(x)$.	[2 marks]
4 (b) (i)	Prove that the graph of $y = p(x)$ intersects the x -axis at exactly one point.	[4 marks]



	
4 (b) (ii)	State the coordinates of this point of intersection. [1 mark]
	Turn over for the next question



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5	The number of radioactive atoms, N , in a sample of a sodium isotope after time t hours can be modelled by
	$N = N_0 e^{-kt}$
	where N_{0} is the initial number of radioactive atoms in the sample and k is a positive constant.
	The model remains valid for large numbers of atoms.
5 (a)	It takes 15.9 hours for half of the sodium atoms to decay.
	Determine the number of days required for at least 90% of the number of atoms in the original sample to decay. [5 marks]

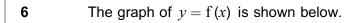


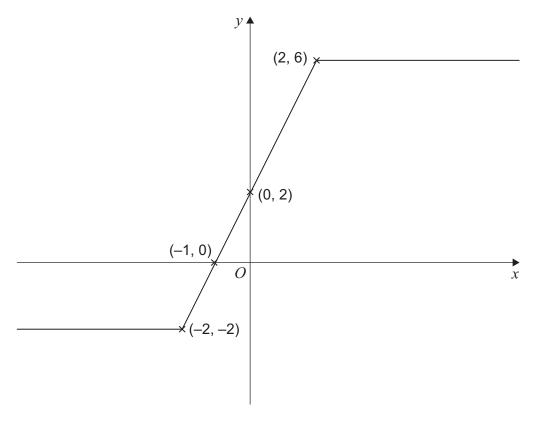
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5 (b)	Find the percentage of the atoms remaining after the first week.	
	Give your answer to two significant figures.	[2 marks]
5 (a)	Evelois why the model can only provide an estimate for the pyrother of remain	
5 (c)	Explain why the model can only provide an estimate for the number of rema atoms.	[1 mark]
5 (d)	Explain why the model is invalid in the long run.	[1 mark]
	Turn over for the next question	

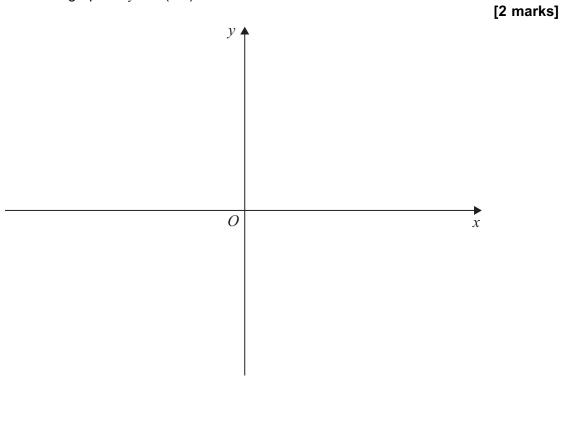








6 (a) Sketch the graph of y = f(-x)

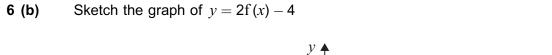


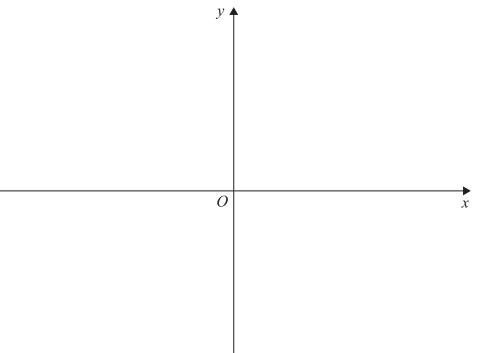


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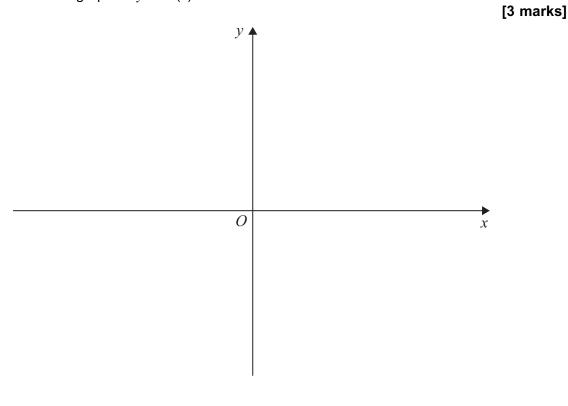


[2 marks]





6 (c) Sketch the graph of y = f'(x)



Turn over for the next question

Turn over ▶



7 (a)	Using ${}^{n}C_{r} = \frac{n!}{r!(n-r)!}$ show that ${}^{n}C_{2} = \frac{n(n-1)}{2}$	[2 marks]
7 (b) (i)	Show that the equation	
	$2 \times {}^{n}C_{4} = 51 \times {}^{n}C_{2}$	
	simplifies to	
	$n^2 - 5n - 300 = 0$	
		[3 marks]



7 (b) (ii)	Hence, solve the equation				
. (3) ()					
	$2 \times {}^{n}C_{4} = 51 \times {}^{n}C_{2}$	10			
		[2 marks]			
	Turn over for the next question				
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8	The sum to infinity of a geometric series is 96	
	The first term of the series is less than 30	
	The second term of the series is 18	
8 (a)	Find the first term and common ratio of the series.	[5 marks]
		[o marko]
8 (b) (i)	Show that the n th term of the series, u_n , can be written as	
	$u_n = \frac{3^n}{2^{2n-5}}$	
		[4 marks]



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8 (b) (ii)	Hence show that		
- (, (,			
		$\log u = v(1 - 2\log 2) + 5\log 2$	
	1	$\log_3 u_n = n(1 - 2\log_3 2) + 5\log_3 2$ [3 marks]	I
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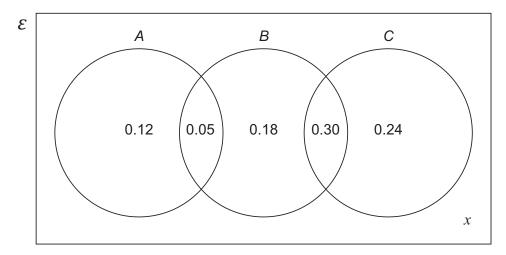
9 (a)	For $\cos heta eq 0$, prove that		
		$\csc 2\theta + \cot 2\theta = \cot \theta$	
			[4 marks]
	,		
9 (b)	Explain why		
		$\cot heta eq \operatorname{cosec} 2 heta + \cot 2 heta$	
		$\cot \theta \neq \cot 2\theta + \cot 2\theta$	
	when $\cos \theta = 0$		[1 mark]
			[



Section B

Answer all questions in the spaces provided.

The probabilities of events *A*, *B* and *C* are related, as shown in the Venn diagram below.



Find the value of *x*.

Circle your answer.

[1 mark]

0.11

0.46

0.54

0.89

The table below shows the temperature on Mount Everest on the first day of each month.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	-17	-16	-14	-9	-2	2	6	5	-3	-4	-11	-18

Calculate the standard deviation of these temperatures.

Circle your answer.

[1 mark]

-6.75

5.82

8.24

67.85

The box plot below summarises the ${\rm CO_2}$ emissions, in g/km, for cars in the Large Data Set from the London and North West regions. 12 London 39 119 142 168 346 North West 13 356 118 129 155 0 50 100 150 200 250 300 350 400 12 (a) Using the box plot, give one comparison of central tendency and one comparison of spread for the two regions. [2 marks] Comparison of central tendency Comparison of spread



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box

12 (b)	Jaspal, an environmental researcher, used all of the data in the Large Data Set to produce a statistical comparison of the CO ₂ and CO emissions in regions of England. Using your knowledge of the Large Data Set, give two reasons why his conclusions
	may be invalid.
	[2 marks]
	Turn over for the next question



13	Diedre is a head teacher in a school which provides primary, secondary and sixth-form education.
	There are 200 teachers in her school.
	The number of teachers in each level of education along with their gender is shown in the table below.
	Primary Secondary Sixth-form
	Male 9 24 23
	Female 35 85 24
13 (a) 13 (a) (i)	A teacher is selected at random. Find the probability that: the teacher is female [1 mark]
13 (a) (ii)	the teacher is not a sixth-form teacher. [1 mark]
13 (b)	Given that a randomly chosen teacher is male, find the probability that this teacher is not a primary teacher. [2 marks]

-		

13 (c)	Diedre wants to select three different teachers at random to be part of a school project.						
	Calculate the probability that all three chosen are secondary teachers.	[2 marks]					
	Turn over for the next question						



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	It is known that a h Emergency (A&E)		s a me	an waiti	ng time	of 4 ho	ours for its Ac	cident and
	After some new ini hospital's A&E Dep							ents from the
		4.25	3.90	4.15	3.95	4.20	4.15	
		5.00	3.85	4.25	4.05	3.80	3.95	
	Carry out a hypoth mean waiting time							whether the
	You may assume to deviation 0.8 hours		aiting tir	nes are	norma	lly distri	buted with sta	andard
								[7 marks]
-								
								
								



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Turn over ▶

A political party is holding an election to choose a new leader.
A statistician within the party decides to sample 70 party members to find their opinions of the leadership candidates.
There are 4735 members under 30 years old and 8565 members 30 years old and over.
The statistician wants to use a sample of 70 party members in the survey.
He decides to use a random stratified sample.
Calculate how many of each age group should be included in his sample. [2 marks]
Explain how he could collect the random sample of members under 30 years old. [3 marks]



16	An educational expert found that the correlation coefficient between the hours of revision and the scores achieved by 25 students in their A-level exams was 0.379
	Her data came from a bivariate normal distribution.
	Carry out a hypothesis test at the 1% significance level to determine if there is a positive correlation between the hours of revision and the scores achieved by students in their A-level exams.
	The critical value of the correlation coefficient is 0.4622 [4 marks]

Turn over for the next question



17	The lifetime of Zaple smartphone batteries, X hours, is normally distributed with measure 8 hours and standard deviation 1.5 hours.	ın
17 (a) (i)	Find $P(X \neq 8)$ [1 main	r k]
17 (a) (ii)	Find P(6 $< X <$ 10) [1 main	 r k]
17 (b)	Determine the lifetime exceeded by 90% of Zaple smartphone batteries. [2 mark]	 (s]



17 (c)	A different smartphone, Kaphone, has its battery's lifetime, Y hours, modelled by a normal distribution with mean 7 hours and standard deviation σ .
	25% of randomly selected Kaphone batteries last less than 5 hours.
	Find the value of σ , correct to three significant figures. [4 marks]
	Turn over for the next question



10	defects in shirts.			ole types of			
	Of the shirts table below.	with defects, the p	roportion o	of each type	e of defect	is as show	n in the
		Type of defect	Colour	Fabric	Sewing	Sizing	
		Probability	0.25	0.30	0.40	0.05	
	Shirts with de	efects are packed i	n boxes of	30 at rand	dom.		
18 (a)	Find the prob	pability that:					
18 (a) (i)	a box contair	ns exactly 5 shirts	with a colo	ur defect			[2 marks]
18 (a) (ii)	a box contair	ns fewer than 15 sl	nirts with a	sewing de	efect		[2 marks]



	27	
18 (a) (iii)	a box contains at least 20 shirts which do not have a fabric defect.	[3 marks]
	Question 18 continues on the next page	



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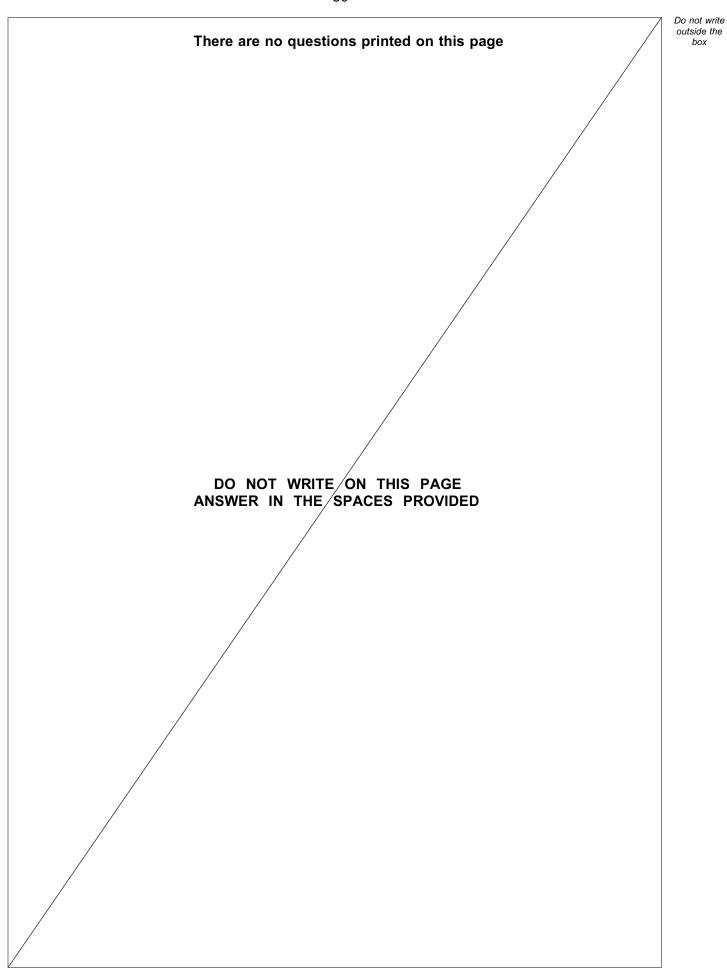
18 (b)	Tiana wants to investigate the proportion, p , of defective shirts with a fabric defect.				
	She wishes to test the hypotheses				
	$H_0: p = 0.3$				
	$H_1: p < 0.3$				
	She takes a random sample of 60 shirts with a defect and finds that \boldsymbol{x} of them have a fabric defect.				
18 (b) (i)	Using a 5% level of significance, find the critical region for x . [5 marks]				



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18 (b) (ii)	In her sample she finds 13 shirts with a fabric defect.	
	Complete the test stating her conclusion in context.	[2 marke]
		[2 marks]
	END OF QUESTIONS	
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Question number	Additional page, if required. Write the question numbers in the left-hand margin.



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