Oxford Cambridge and RSA

Accredited

A Level Further Mathematics B (MEI)
Y436 Further Pure with Technology
Sample Question Paper

Date – Morning/Afternoon
Time allowed: 1 hour 45 minutes

OCR supplied materials:
- Printed Answer Booklet
- Formulae Further Mathematics B (MEI)

You must have:
- Printed Answer Book
- Formulae Further Mathematics B (MEI)
- Scientific or graphical calculator
- Computer with appropriate software

SPECIMEN

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes provided on the Printed Answer Booklet with your name, centre number and candidate number.
- Answer **all** the questions.
- **Write your answer to each question in the space provided in the Printed Answer Booklet.**
- 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.

COMPUTING RESOURCES
- Candidates will require access to a computer with a computer algebra system, a spreadsheet, a programming language and graph-plotting software throughout the examination.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- 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 used. You should communicate your method with correct reasoning.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **8** pages.

Answer **all** the questions.

1 A family of curves has polar equation $r = \cos^n\left(\frac{\theta}{n}\right)$, $0 \le \theta < n\pi$, where n is a positive *even* integer.

(i) (*A*) Sketch the curve for the cases $n = 2$ and $n = 4$. **[2]**

(*B*) State two points which lie on every curve in the family. **[1]**

(*C*) State one other feature common to all the curves. **[1]**

(ii) (*A*) Write down an integral for the length of the curve for the case $n = 4$. **[2]**

(*B*) Evaluate the integral. **[2]**

(iii) (*A*) Using $t = \theta$ as the parameter, find a parametric form of the equation of the family of curves. **[1]**

(*B*) Show that $\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{\sin t \sin\left(\frac{t}{n}\right) - \cos t \cos\left(\frac{t}{n}\right)}{\sin t \cos\left(\frac{t}{n}\right) + \cos t \sin\left(\frac{t}{n}\right)}$. **[2]**

(iv) Hence show that there are $n+1$ points where the tangent to the curve is parallel to the y-axis. **[6]**

(v) By referring to appropriate sketches, show that the result in part **(iv)** is true in the case $n = 4$. **[2]**

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2 **(i)** (*A*) Create a program to find all the solutions to $x^2 \equiv -1 \pmod{p}$ where $0 \le x < p$.

Write out your program in full in the Printed Answer Booklet. **[5]**

(*B*) Use the program to find the solutions to $x^2 \equiv -1 \pmod{p}$ for the primes

- $p = 809$,
- $p = 811$ and
- $p = 444\,001$. **[3]**

(ii) State Wilson's Theorem. **[1]**

(iii) The following argument shows that $(4k)! \equiv ((2k)!)^2 \pmod{p}$ for the case $p = 4k + 1$.

$$(4k)! \equiv 1\times2\times3\times\ldots\times(2k-1)\times2k\times(2k+1)\times(2k+2)\times\ldots\times(4k-1)\times4k \pmod{p} \quad (1)$$

$$\equiv 1\times2\times3\times\ldots\times(2k-1)\times2k\times(-2k)\times(-(2k-1))\times\ldots\times(-2)\times(-1) \pmod{p} \quad (2)$$

$$\equiv ((2k)!)^2 \pmod{p} \quad (3)$$

(*A*) Explain why $(2k+2)$ can be written as $(-(2k-1))$ in line (2). **[1]**

(*B*) Explain how line (3) has been obtained. **[2]**

(*C*) Explain why, if p is a prime of the form $p = 4k + 1$, then $x^2 \equiv -1 \pmod{p}$ will have at least one solution. **[1]**

(*D*) Hence find a solution of $x^2 \equiv -1 \pmod{29}$. **[2]**

(iv) (*A*) Create a program that will find all the positive integers n, where $n < 1000$, such that $(n-1)! \equiv -1 \pmod{n^2}$. Write out your program in full. **[3]**

(*B*) State the values of n obtained. **[2]**

(*C*) A Wilson prime is a prime p such that $(p-1)! \equiv -1 \pmod{p^2}$. Write down all the Wilson primes p where $p < 1000$. **[1]**

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3 This question explores the family of differential equations $\frac{dy}{dx} = \sqrt{1 + ax + 2y}$ for various values of the parameter a. Fig. 3 shows the tangent field in the case $a = 1$.

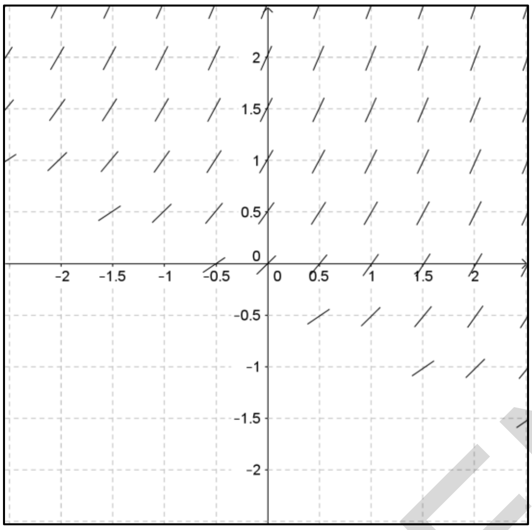

Fig. 3

(i) (*A*) Sketch the tangent field in the case $a = -2$. **[2]**

(*B*) Explain why the tangent field is not defined for the whole coordinate plane. **[1]**

(*C*) Give an inequality which describes the region in which the tangent field is defined. **[1]**

(*D*) Find a value of a such that the region for which the tangent field is defined includes the entire x-axis. **[1]**

(ii) (*A*) For the case $a = 1$, with $y = 1$ when $x = 0$, construct a spreadsheet for the Runge-Kutta method of order 2 with formulae as follows, where $f(x, y) = \frac{dy}{dx}$.

$$k_1 = hf(x_n, y_n)$$
$$k_2 = hf(x_n + h, y_n + k_1)$$
$$y_{n+1} = y_n + \frac{1}{2}(k_1 + k_2)$$

State the formulae you have used in your spreadsheet. **[3]**

(*B*) Use your spreadsheet to obtain the value of y correct to 4 decimal places when $x = 1$ for

- $h = 0.1$

and

- $h = 0.05$. **[2]**

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(iii) (*A*) For the case $a = 0$ find the analytical solution that passes through the point $(0, 1)$. **[1]**

(*B*) Verify that the solution in part **(iii)** (*A*) is a solution to the differential equation. **[2]**

(*C*) Use the solution in part **(iii)** (*A*) to find the value of *y* correct to 4 decimal places when $x = 1$. **[1]**

(iv) (*A*) Verify that $y = -\frac{a}{2}x + \frac{a^2}{8} - \frac{1}{2}$ is a solution for all cases when $a \leq 0$. **[2]**

(*B*) Show that this is the only straight line solution in these cases. **[4]**

END OF QUESTION PAPER

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…day June 20XX – Morning/Afternoon

A Level Further Mathematics B (MEI)
Y436 Further pure with technology

SAMPLE MARK SCHEME

Duration: 1 hour 45 minutes

MAXIMUM MARK 60

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This document consists of 16 pages

Text Instructions

1. Annotations and abbreviations

Annotation in scoris	Meaning
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining a result or establishing a given result
U1	Mark for correct units
G1	Mark for a correct feature on a graph
dep*	Mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	This indicates that the instruction **In this question you must show detailed reasoning** appears in the question.

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2. Subject-specific Marking Instructions for A Level Further Mathematics B (MEI)

a Annotations should be used whenever appropriate during your marking. The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded. For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct solutions leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly. Correct but unfamiliar or unexpected methods are often signalled by a correct result following an apparently incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
If you are in any doubt whatsoever you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E
A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more ‘method’ steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation ‘dep*’ is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

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e The abbreviation FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, what is acceptable will be detailed in the mark scheme. If this is not the case please, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (e.g. lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.) We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so. When a value is given in the paper only accept an answer correct to at least as many significant figures as the given value. This rule should be applied to each case. When a value is not given in the paper accept any answer that agrees with the correct value to 2 s.f. Follow through should be used so that only one mark is lost for each distinct accuracy error, except for errors due to premature approximation which should be penalised only once in the examination. There is no penalty for using a wrong value for g. E marks will be lost except when results agree to the accuracy required in the question.

g Rules for replaced work: if a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests; if there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others. NB Follow these maths-specific instructions rather than those in the assessor handbook.

h For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question. Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working. 'Fresh starts' will not affect an earlier decision about a misread. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i If a graphical calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers (provided, of course, that there is nothing in the wording of the question specifying that analytical methods are required). Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j If in any case the scheme operates with considerable unfairness consult your Team Leader.

k Anything in the mark scheme which is in square brackets […] is not required for the mark to be earned on this occasion, but shows what a complete solution might look like

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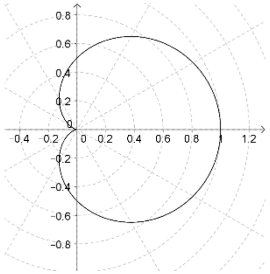
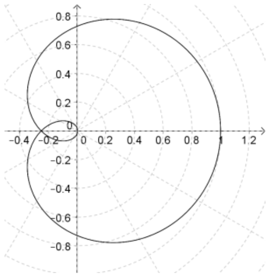
Question			Answer	Marks	AOs	Guidance	
1	(i)	(*A*)	$n = 2$ 	B1	1.1		
			$n = 4$ 	B1	1.1		
				[2]			
1	(i)	(*B*)	Curves pass through (0, 0) and (1, 0)	B1	1.1		
				[1]			
1	(i)	(*C*)	e.g. Curves are bounded e.g. Curves are symmetrical about the line $\theta = 0$ e.g. Curves have cusps at the pole.	B1	2.2b	B1 for one common feature Accept "Curves are symmetrical about the *x*-axis"	
				[1]			

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Question			Answer	Marks	AOs	Guidance	
1	**(ii)**	(*A*)	Length = $\int_0^{4\pi} \sqrt{\left(\frac{\mathrm{d}r}{\mathrm{d}\theta}\right)^2 + r^2}\,\mathrm{d}\theta$	**M1** **M1** **[2]**	**1.2** **1.1a**	Correct formula seen Correct limits seen	
1	**(ii)**	(*B*)	$\frac{\mathrm{d}r}{\mathrm{d}\theta} = -\sin\frac{\theta}{4}\cos^3\frac{\theta}{4}$ $= \frac{16}{3}$	**A1** **A1** **[2]**	**1.1** **1.1**	soi	
1	**(iii)**	(*A*)	$x = \cos^n\left(\frac{t}{n}\right)\cos t,\ y = \cos^n\left(\frac{t}{n}\right)\sin t$	**B1** **[1]**	**1.1**		

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Question			Answer	Marks	AOs	Guidance	
1	(iii)	(*B*)	$\dfrac{dy}{dx}=\dfrac{\frac{dy}{dt}}{\frac{dx}{dt}}$ $=\dfrac{n\cos^{n-1}\left(\frac{t}{n}\right)\left(-\frac{1}{n}\sin\left(\frac{t}{n}\right)\right)\sin t+\cos^{n}\left(\frac{t}{n}\right)\cos t}{n\cos^{n-1}\left(\frac{t}{n}\right)\left(-\frac{1}{n}\sin\left(\frac{t}{n}\right)\right)\cos t-\cos^{n}\left(\frac{t}{n}\right)\sin t}$	M1	1.1	Evidence of use of derivative	
			$=\dfrac{-\cos^{n-1}\left(\frac{t}{n}\right)\left(\sin t\sin\left(\frac{t}{n}\right)-\cos t\cos\left(\frac{t}{n}\right)\right)}{-\cos^{n-1}\left(\frac{t}{n}\right)\left(\sin t\cos\left(\frac{t}{n}\right)+\cos t\sin\left(\frac{t}{n}\right)\right)}$ $=\dfrac{\sin t\sin\left(\frac{t}{n}\right)-\cos t\cos\left(\frac{t}{n}\right)}{\sin t\cos\left(\frac{t}{n}\right)+\cos t\sin\left(\frac{t}{n}\right)}$ AG	A1 [2]	2.1		

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Question			Answer	Marks	AOs	Guidance	
1	(iv)		$\sin t \cos\left(\frac{t}{n}\right) + \cos t \sin\left(\frac{t}{n}\right) = 0$	M1	3.1a	Set denominator of dy/dx=0	
			$\sin\left(\frac{n+1}{n}t\right) = 0$	M1	1.1	Or equivalent expression.	
			$\frac{n+1}{n}t = 0, \pi, 2\pi, 3\pi...$	M1	1.1		
			In the range $0 \le t < n\pi$ roots are:	M1	3.1a		
			$t = 0, \frac{n}{n+1}\pi, \frac{2n}{n+1}\pi, \frac{3n}{n+1}\pi, ..., \frac{n^2}{n+1}\pi$	A1	2.1		
			Numerator: $-\cos\left(\frac{n+1}{n}t\right)$ $\neq 0$ for any of these values therefore all n+1 are points where the tangent is parallel to the y-axis.	E1	2.4	Alternative based on $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{-1}{\tan t}$ is acceptable	
				[6]			
1	(v)		States looking for 5 and zooms in on origin	M1	1.1		
			Shows 5 points clearly with appropriate sketches and no errors	A1	2.4		
				[2]			

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AOs</th><th colspan="2">Guidance</th></tr>
<tr><td>2</td><td>(i)</td><td>(A)</td><td>If some (or all) of the answers are incorrect allocate method marks as follows:
Appropriate structure program: candidates should be forming a loop that checks and returns multiple possible solutions of the congruence.
Appropriate use of variables: evidence of separate input variable and a variable used for the different values of x.
Loop for x or equivalent: clear attempt to try different values systematically.
Suitable values checked: evidence that 0 to p-1 is used mod$p$, or equivalent.
Check (If) statement: evidence of using an appropriate modulo/remainder statement in the check.</td><td>M1
M1
M1
M1
M1
[5]</td><td>3.3
3.3
2.1
1.1
2.5</td><td>Appropriate structure program with all solutions correct scores M5B2A1.
Example code for Python v3.6 (may include ‘import math’)
<pre>def prog1(p):
    for i in range(0,p):
        if (i*i)%p==p-1:
            print(i)</pre></td><td></td></tr>
<tr><td>2</td><td>(i)</td><td>(B)</td><td>p=809: x=318, 491
p=811: no solutions
p=444 001: x=184 229, 259 772</td><td>B1
B1
A1
[3]</td><td>1.1
3.4
1.1</td><td>Interpreting no output as no solutions</td><td></td></tr>
<tr><td>2</td><td>(ii)</td><td></td><td>$(p-1)!\equiv -1 \pmod p$ if and only if p is prime.</td><td>B1
[1]</td><td>1.2</td><td>Accept
p is prime $\Rightarrow$ $(p-1)!\equiv -1 \pmod p$</td><td></td></tr>
</table>

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Question			Answer	Marks	AOs	Guidance	
2	(iii)	(*A*)	$(2k+2) \equiv ((2k+2)-(4k+1))(\text{mod } p)$ $\equiv (-(2k-1))(\text{mod } p)$	B1 [1]	2.3		
2	(iii)	(*B*)	$-2k = (-1)\times(2k)$, $-(2k-1) = (-1)\times(2k-1)$ … so the product of all these terms is $(-2k)\times(-(2k-1))\times\ldots\times(-2)\times(-1)$ $= 2k\times(2k-1)\times\ldots\times 3\times 2\times 1\times(-1)^{2k}$ $= (2k)!$ The product of the first $2k$ terms is $(2k)!$ Therefore $(4k)! \equiv ((2k)!)^2(\text{mod } p)$	M1 A1 [2]	2.3 1.1		
2	(iii)	(*C*)	$x^2 \equiv -1(\text{mod } p)$ will have solution $x = (2k)!$	B1 [1]	2.2a		
2	(iii)	(*D*)	$x \equiv 14!(\text{mod } 29)$ $\equiv 12(\text{mod } 29)$	M1 A1 [2]	3.1a 1.1		

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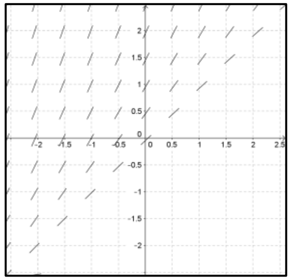
Question			Answer	Marks	AOs	Guidance	

2	(iv)	(*A*)	If some (or all) of the answers are incorrect or there is insufficient evidence of checking all cases allocate method marks as follows:
			Checking all cases <1000 using a loop or equivalent.
			Using an appropriate modulo/remainder function.
			Suitable if statement, or equivalent to compare to p^2-1.
				
				B1
				B1
				B1
				[3]
					
					1.1
					3.1a
					1.1a
						Any correct method resulting in only n=1, 5, 13 and 563 and checking all other cases scores **M3A2B1**.
						Example code for Python v3.6 (may include 'import math')
						`def prog2():`
						`    for i in range(1,1001):`
						`        if math.factorial(i-1)%(i*i)==(i*i)-1:`
						`            print(i)`	

2	(iv)	(*B*)	Only values are n = 1, 5, 13 and 563.	**B1** **B1** **[2]**	3.1a 1.1	n=1, 5 13 and 563 No other values.	
2	(iv)	(*C*)	Wilson primes (<1000): 5, 13 and 563	**B1** **[1]**	3.2a	Evidence of checking 563 is prime not required.	

SPECIMEN

Question			Answer	Marks	AOs	Guidance	
3	**(i)**	(*A*)	$a = -2$ 	**M1** **A1** **[2]**	**1.1** **1.1**	Correct in at least one quadrant Correct everywhere	
3	**(i)**	(*B*)	$\frac{\mathrm{d}y}{\mathrm{d}x}$ is not defined when $1+ax+2y<0$ because the square root is not real.	**E1** **[1]**	**2.4**		
3	**(i)**	(*C*)	$\frac{\mathrm{d}y}{\mathrm{d}x}$ is defined when $y \geq -\frac{a}{2}x - \frac{1}{2}$ o.e.	**B1** **[1]**	**2.2a**		
3	**(i)**	(*D*)	$a = 0$	**B1** **[1]**	**1.1**	may be obtained by using slider on their tangent field – no evidence required – or by using **(i)** (*B*)	

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Question			Answer	Marks	AOs	Guidance	
3	**(ii)**	(*A*)	A2=0.1 B2=0, C2=1 D2= $A$2*sqrt(1+B2+2*C2), E2= $A$2*sqrt(1+(B2+$A$2)+2*(C2+D2)) B3= B2+$A$2, C3 =C2+0.5*(D2+E2) or define: *h*=0.1, f(*x*,*y*)=sqrt(1+*x*+2*y*) A2=0, B2=1 C2=*h**f(A2, B2), D2=*h**f(A2 + h, B2 + C2) A3=A2+*h*, B3=B2 + 0.5*(C2 + D2)	 **M1** **M1** **M1** **[3]**	 **1.1** **3.1a** **2.5**	 Columns for x & y or equivalent Columns for k_1 & k_2 or equivalent Formulae for x_{n+1} & y_{n+1}	
3	**(ii)**	(*B*)	$h = 0.1$: $y = 3.3488$ when $x = 1$ $h = 0.05$: $y = 3.3500$ when $x = 1$	**A1** **A1** **[2]**	**1.1** **3.2a**		

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Question			Answer	Marks	AOs	Guidance	
3	(iii)	(*A*)	$y=\frac{1}{2}x^2+\sqrt{3}x+1$	B1 [1]	2.2a		
3	(iii)	(*B*)	$\frac{dy}{dx}=x+\sqrt{3}$ $=\sqrt{x^2+2\sqrt{3}x+3}$ $=\sqrt{1+2\left(\frac{1}{2}x^2+\sqrt{3}x+1\right)}$ $=\sqrt{1+2y}$	M1 A1 [2]	1.1 2.1	Clear reasoning must be seen throughout	
3	(iii)	(*C*)	$y = 3.2321$ when $x = 1$	B1 [1]	1.1		

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Question			Answer	Marks	AOs	Guidance	
3	(iv)	(*A*)	$\sqrt{1+ax+2\left(-\frac{a}{2}x+\frac{a^2}{8}-\frac{1}{2}\right)}=\sqrt{\frac{a^2}{4}}$ $=-\frac{a}{2}$ $=\frac{\mathrm{d}y}{\mathrm{d}x}$	M1 A1 [2]	2.1 2.4	As $a<0$ positive root is $-\frac{a}{2}$. Must give convincing reason for negative sign	
3	(iv)	(*B*)	Substituting in $y=mx+c$ gives $m=\sqrt{1+ax+2mx+2c}$ m independent of x requires $ax+2mx=0$ therefore $m=-\frac{a}{2}$. $-\frac{a}{2}=\sqrt{1+2c}$ $\Rightarrow c=\frac{a^2}{8}-\frac{1}{2}$	M1 A1 M1 A1 [4]	3.1a 2.2a 1.1 2.2a	Accept $-\frac{a}{2}=\sqrt{1+ax+2\left(-\frac{a}{2}x+c\right)}$	

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Question	AO1	AO2	AO3(PS)	AO3(M)	Totals
1iA	2	0	0	0	2
1iB	1	0	0	0	1
1iC	0	1	0	0	1
1iiA	2	0	0	0	2
1iiB	2	0	0	0	2
1iiiA	1	0	0	0	1
1iiiB	1	1	0	0	2
1iv	2	2	2	0	6
1v	1	1	0	0	2
2iA	1	2	0	2	5
2iB	2	0	0	1	3
2ii	1	0	0	0	1
2iiiA	0	1	0	0	1
2iiiB	1	1	0	0	2
2iiiC	0	1	0	0	1
2iiiD	1	0	1	0	2
2ivA	2	0	1	0	3
2ivB	1	0	1	0	2
2ivC	0	0	1	0	1
3iA	2	0	0	0	2
3iB	0	1	0	0	1
3iC	0	1	0	0	1
3iD	1	0	0	0	1
3iiA	1	1	1	0	3
3iiB	1	0	1	0	2
3iii	2	2	0	0	4
3iv	1	4	1	0	6
totals	29	19	9	3	60

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A Level Further Mathematics B (MEI)

Y436 Further Pure with Technology

Printed Answer Booklet

Date – Morning/Afternoon

Time allowed: 1 hour 45 minutes

OCR supplied materials:
- Printed Answer Booklet
- Formulae Further Mathematics B (MEI)

You must have:
- Printed Answer Booklet
- Formulae Further Mathematics B (MEI)
- Scientific or graphical calculator
- Computer with appropriate software

First name	
Last name	

Centre number						**Candidate number**				

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INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes provided on the Printed Answer Booklet with your name, centre number and candidate number.
- Answer **all** the questions.
- **Write your answer to each question in the space provided in the Printed Answer Booklet.**
- 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.

COMPUTING RESOURCES
- Candidates will require access to a computer with a computer algebra system, a spreadsheet, a programming language and graph-plotting software throughout the examination.

INFORMATION
- 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 used.
- The Printed Answer Booklet consists of **12** pages. The Question Paper consists of **4** pages.

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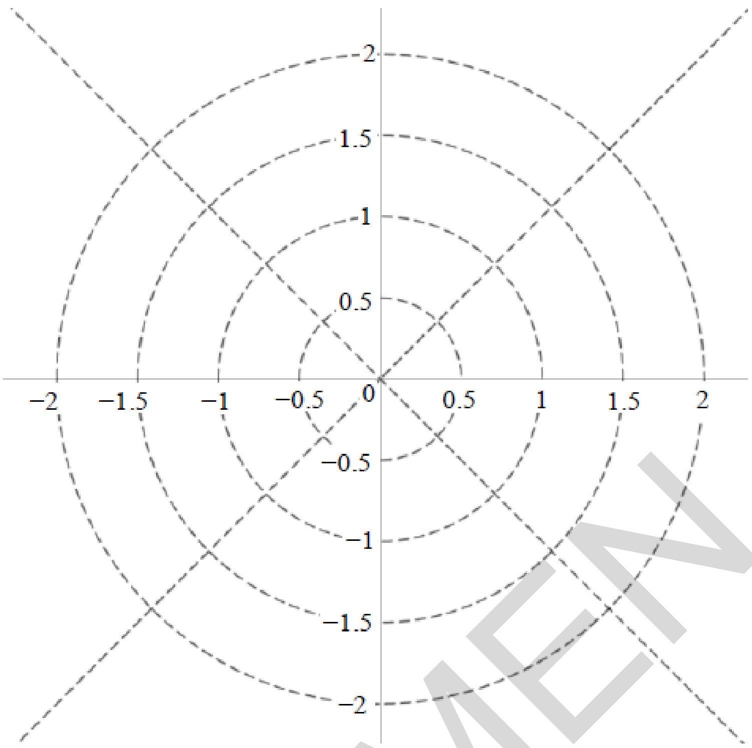
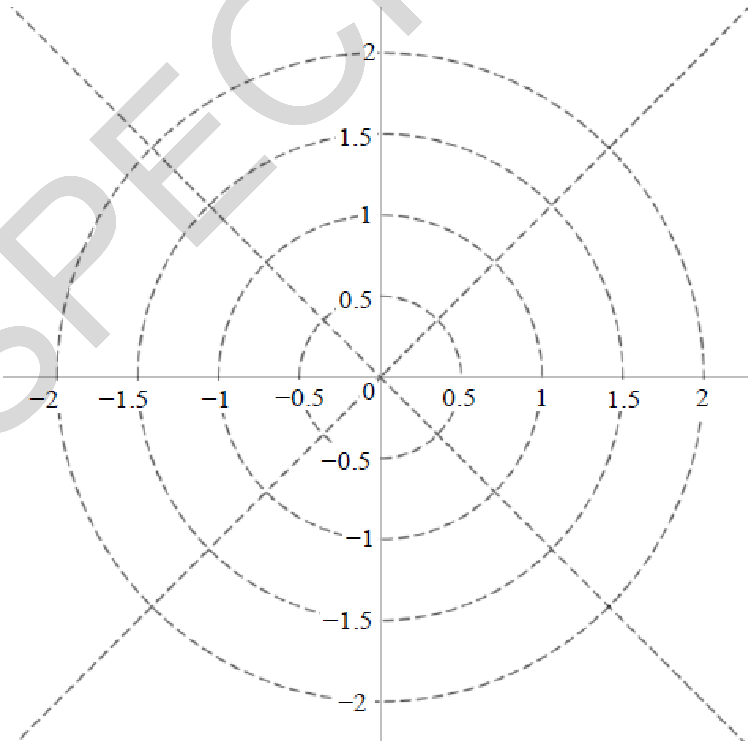
1 (i) (A)	$n = 2$  $n = 4$ 

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1 (i) (*B*)	
1 (i) (*C*)	
1 (ii) (*A*)	
1 (ii) (*B*)	

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1 (iii) (*A*)	
1 (iii) (*B*)	
1 (iv)	
	(answer space continued on next page)

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1 (iv)	**(continued)**
1 (v)	

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2 (i) (*A*)	
2 (i) (*B*)	
2 (ii)	

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2 (iii) (A)	
2 (iii) (B)	
2 (iii) (C)	
2 (iii) (D)	

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2 (iv) (*A*)	
2 (iv) (*B*)	
2 (iv) (*C*)	

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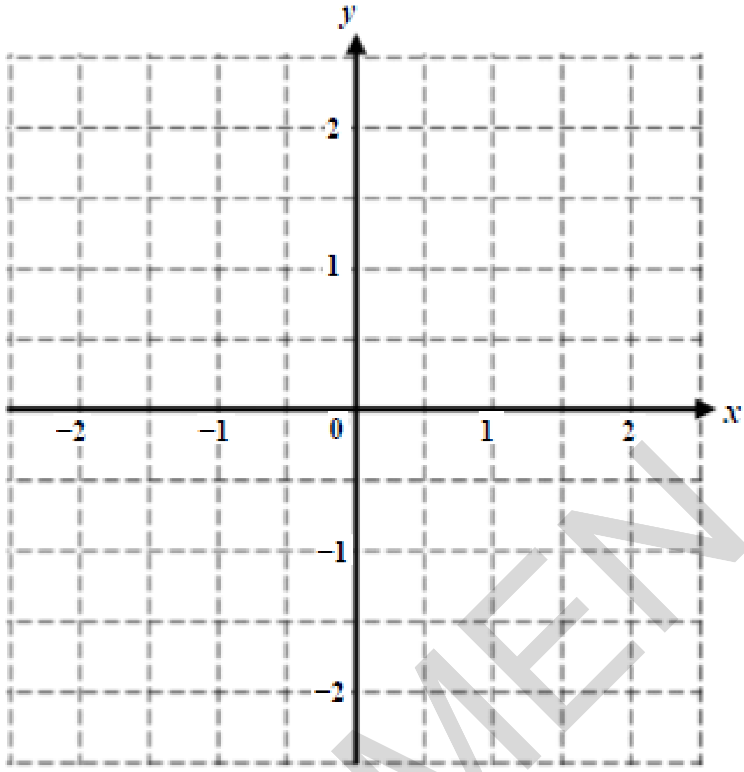
3 (i) (*A*)	$a = -2$ 
3 (i) (*B*)	
3 (i) (*C*)	
3 (i) (*D*)	

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3 (ii) (*A*)	
3 (ii) (*B*)	
3 (iii) (*A*)	
3 (iii) (*B*)	
3 (iii) (*C*)	

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3 (iv) (*A*)

3 (iv) (*B*)

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