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Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

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3066025384 8

ADDITIONAL MATHEMATICS **0606/11**

Paper 1 **October/November 2019**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** the questions.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
The use of an electronic calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 80.

This document consists of **16** printed pages.

Cambridge Assessment International Education

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

Binomial Theorem

$$(a + b)^n = a^n + \binom{n}{1} a^{n-1} b + \binom{n}{2} a^{n-2} b^2 + \ldots + \binom{n}{r} a^{n-r} b^r + \ldots + b^n,$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{(n-r)!r!}$.

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

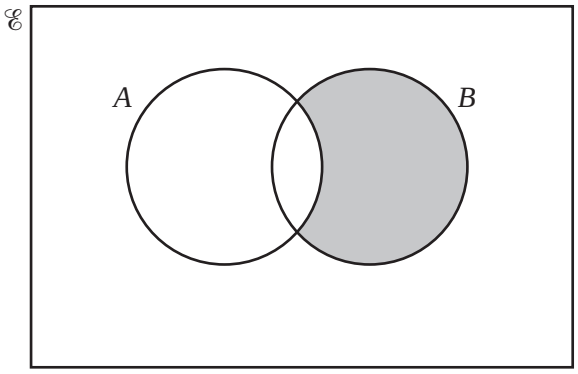
Formulae for ΔABC

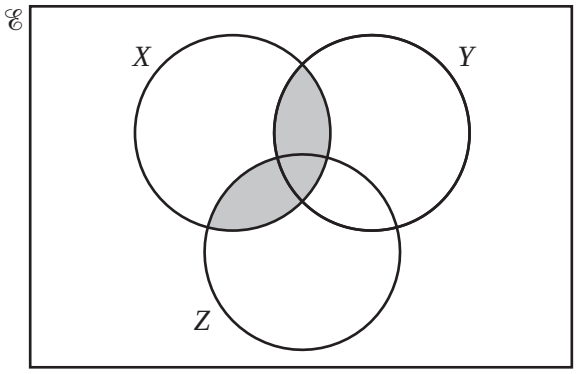
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$\Delta = \frac{1}{2} bc \sin A$$

1 Using set notation, describe the regions shaded on the Venn diagrams below.





.... [2]

2 Find the values of k for which the line $y = kx - 3$ and the curve $y = 2x^2 + 3x + k$ do not intersect. [5]

[Turn over

3 Given that $7^x \times 49^y = 1$ and $5^{5x} \times 125^{\frac{2y}{3}} = \frac{1}{25}$, calculate the value of x and of y. [5]

4 It is given that $y = \dfrac{\ln(4x^2+1)}{2x-3}$.

(i) Find $\dfrac{dy}{dx}$. [3]

(ii) Find the approximate change in y as x increases from 2 to $2+h$, where h is small. [2]

[Turn over

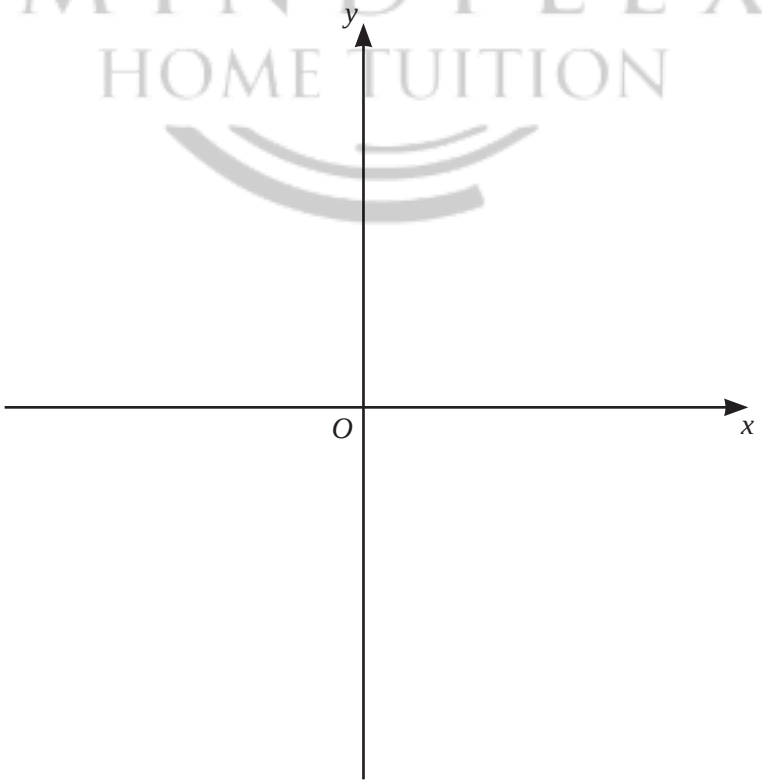
5 $\mathrm{f}(x) = 3\mathrm{e}^{2x} + 1 \quad$ for $x \in \mathbb{R}$

$\mathrm{g}(x) = x + 1 \quad$ for $x \in \mathbb{R}$

(i) Write down the range of f and of g. [2]

(ii) Evaluate $\mathrm{fg}^2(0)$. [2]

(iii) On the axes below, sketch the graphs of $y = \mathrm{f}(x)$ and $y = \mathrm{f}^{-1}(x)$, stating the coordinates of the points where the graphs meet the coordinate axes. [3]



6 Find the equation of the normal to the curve $y = \sqrt{8x+5}$ at the point where $x = \frac{1}{2}$, giving your answer in the form $ax + by + c = 0$, where a, b and c are integers. [5]

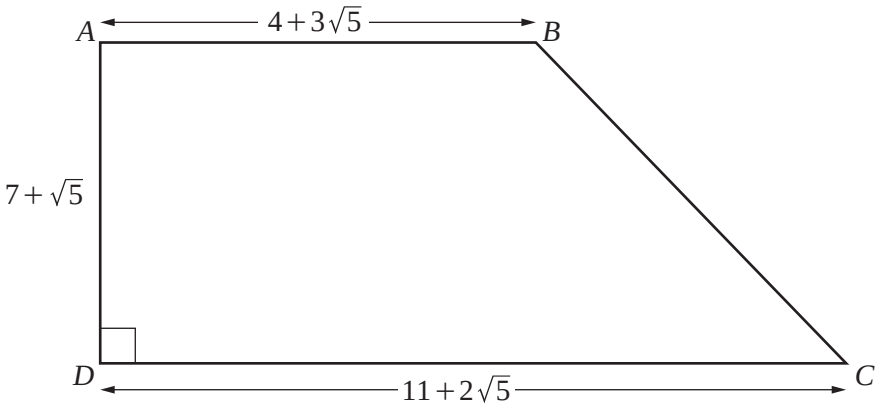
7 When lg y is plotted against x, a straight line graph passing through the points (2.2, 3.6) and (3.4, 6) is obtained.

(i) Given that $y = Ab^x$, find the value of each of the constants A and b. [5]

(ii) Find x when $y = 900$. [2]

8 Do not use a calculator in this question.

In this question, all lengths are in centimetres.



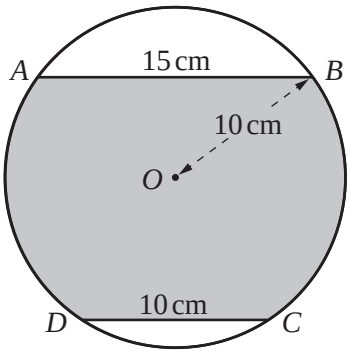
The diagram shows the trapezium $ABCD$ in which angle ADC is 90° and AB is parallel to DC. It is given that $AB = 4 + 3\sqrt{5}$, $DC = 11 + 2\sqrt{5}$ and $AD = 7 + \sqrt{5}$.

(i) Find the perimeter of the trapezium, giving your answer in simplest surd form. [3]

(ii) Find the area of the trapezium, giving your answer in simplest surd form. [3]

[Turn over

9



The diagram shows a circle with centre O and radius 10 cm. The points A, B, C and D lie on the circle such that the chord $AB = 15$ cm and the chord $CD = 10$ cm. The chord AB is parallel to the chord DC.

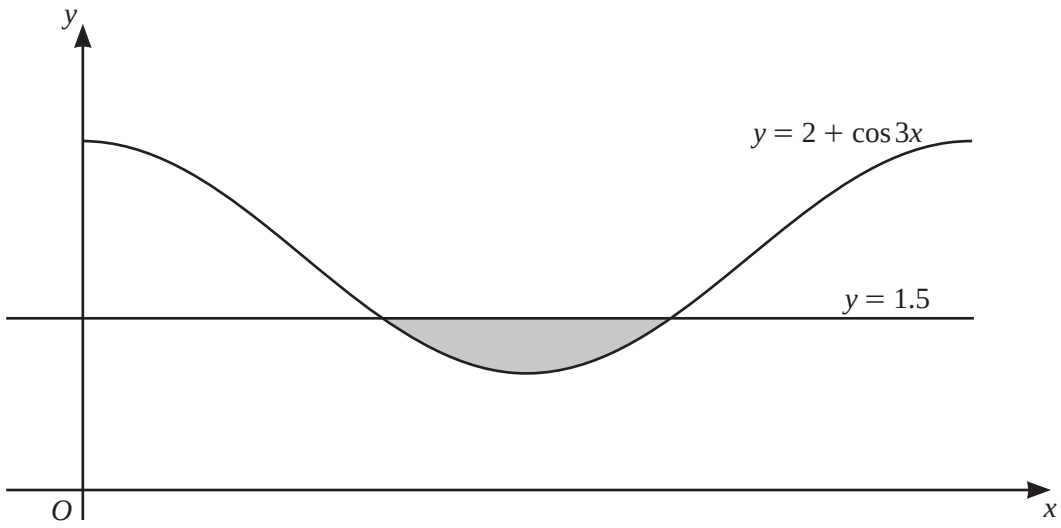
(i) Show that the angle AOB is 1.70 radians correct to 2 decimal places. [2]

(ii) Find the perimeter of the shaded region. [4]

(iii) Find the area of the shaded region. [4]

[Turn over

10



The diagram shows part of the graph of $y = 2 + \cos 3x$ and the straight line $y = 1.5$. Find the exact area of the shaded region bounded by the curve and the straight line. You must show all your working. [9]

Continuation of working space for Question 10

[Turn over

11 **(a)** Jess wants to arrange 9 different books on a shelf. There are 4 mathematics books, 3 physics books and 2 chemistry books. Find the number of different possible arrangements of the books if

(i) there are no restrictions, [1]

(ii) a chemistry book is at each end of the shelf, [2]

(iii) all the mathematics books are kept together and all the physics books are kept together. [3]

(b) A quiz team of 6 children is to be chosen from a class of 8 boys and 10 girls. Find the number of ways of choosing the team if

(i) there are no restrictions, [1]

(ii) there are more boys than girls in the team. [4]

Question 12 is printed on the next page.

[Turn over

12 A curve is such that $\frac{d^2y}{dx^2} = 2\sin\left(x+\frac{\pi}{3}\right)$. Given that the curve has a gradient of 5 at the point $\left(\frac{\pi}{3}, \frac{5\pi}{3}\right)$, find the equation of the curve. [8]

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Paper 1 **October/November 2019**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **10** printed pages.

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[Turn over

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

MARK SCHEME NOTES

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

M Method marks, awarded for a valid method applied to the problem.

A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.

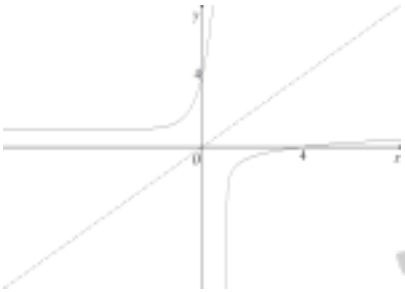
B Mark for a correct result or statement independent of Method marks.

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 M or B mark is dependent on an earlier mark in the scheme.

Abbreviations

awrt	answers which round to
cao	correct answer only
dep	dependent
FT	follow through after error
isw	ignore subsequent working
nfww	not from wrong working
oe	or equivalent
rot	rounded or truncated
SC	Special Case
soi	seen or implied

Question	Answer	Marks	Guidance
1	$A' \cap B$ oe	**B1**	
	$(X \cap Y) \cup (X \cap Z)$ or $X \cap (Y \cup Z)$	**B1**	
2	$2x^2 + 3x + k = kx - 3$	**M1**	For an attempt to equate and simplify to a 3 term quadratic equation, allow an error in one term
	$2x^2 + (3-k)x + (k+3) = 0$	**A1**	
	$(3-k)^2 - 4 \times 2 \times (k+3)$	**M1**	For attempt to use the discriminant, allow previous error, leading to a quadratic equation in terms of k
	$k^2 - 14k - 15 = 0$ giving critical values of -1 and 15	**A1**	For critical values
	$-1 < k < 15$	**A1**	
3	Either $7^x \times 7^{2y}$ or $49^{\frac{x}{2}} \times 49^y$ or $5^{5x} \times 5^{2y}$ or $25^{\frac{5x}{2}} \times 25^y$	**M1**	For expressing the terms on the left hand side of either one of the 2 equations in terms of powers of 7, 49, 5 or 25
	$7^x \times 7^{2y} = 7^0$ or $49^{\frac{x}{2}} \times 49^y = 49^0$	**A1**	
	$5^{5x} \times 5^{2y} = 5^{-2}$ or $25^{\frac{5x}{2}} \times 25^y = 25^{-1}$	**A1**	
	leading to $x + 2y = 0$ and $5x + 2y = -2$	**M1**	For attempt to solve two linear equations, with integer coefficients and constants, in terms of x and y
	$x = -\frac{1}{2}$, $y = \frac{1}{4}$	**A1**	
4(i)	$\frac{\mathrm{d}}{\mathrm{d}x}\left(\ln\left(4x^2+1\right)\right) = \frac{8x}{4x^2+1}$	**B1**	
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{(2x-3)\frac{8x}{(4x^2+1)} - 2\ln(4x^2+1)}{(2x-3)^2}$	**M1**	For attempt to differentiate a quotient
		A1	For all other terms, not including $\frac{8x}{4x^2+1}$, correct
4(ii)	When $x = 2$, $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{16}{17} - 2\ln 17$ $= -4.73$	**M1**	For attempt to find value of $\frac{\mathrm{d}y}{\mathrm{d}x}$ when $x = 2$ and multiply by h
	Change in $y = -4.73h$	**A1**	

Question	Answer	Marks	Guidance
5(i)	$f > 1$	**B1**	Must be using correct notation
	$g \in \mathbb{R}$	**B1**	Must be using correct notation
5(ii)	$g(0) = 1,\ g(1) = 2$ and attempt at $f(2)$	**M1**	For attempt at g^2 and correct order
	$f(2) = 164.8$ awrt 165	**A1**	
5(iii)		**B3**	**B1** for correct f and $(0,4)$, must be in first and second quadrant **B1** for correct f^{-1} and $(4,0)$, must be in first and fourth quadrant **B1** for $y = x$ and/or symmetry implied, by 'matching intercepts'. No intersection.
6	$\frac{dy}{dx} = k(8x + 5)^{-\frac{1}{2}}$	**M1**	For attempt to differentiate, must be in the form $k(8x + 5)^{-\frac{1}{2}}$
	$\frac{dy}{dx} = 4(8x + 5)^{-\frac{1}{2}}$	**A1**	
	When $x = \frac{1}{2}$, $y = 3$	**B1**	
	Normal: $y - 3 = -\frac{3}{4}\left(x - \frac{1}{2}\right)$	**M1**	For attempt at the normal when $x = \frac{1}{2}$, using correct process for *their* $\frac{dy}{dx}$ and *their y*.
	$6x + 8y - 27 = 0$	**A1**	

Question	Answer	Marks	Guidance
7(i)	$\lg y = \lg A + x \lg b$	**B1**	For statement, may be implied by subsequent work
	Either $6 = \lg A + 3.4 \lg b$ or $3.6 = \lg A + 2.2 \lg b$	**M1**	For one correct equation
		M1	For another correct equation and attempt to solve simultaneously
	$\lg b = 2$, $b = 100$	**A1**	
	$\lg A = –0.8$, $A = 10^{–0.8}$ or 0.158	**A1**	
	Or Gradient = $\lg b = 2$	**M1**	equating gradient to $\lg b$ and attempt to evaluate
	$b = 100$	**A1**	Must be identified as b
	$6 = \lg A + 3.4 \lg b$ or $3.6 = \lg A + 2.2 \lg b$	**M1**	For a correct equation and attempt to find $\lg A$
	$\lg A = –0.8$, $A = 10^{–0.8}$ or 0.158	**A1**	Must be identified as A
7(ii)	$\lg 900 = –0.8 + 2x$ oe	**M1**	For correct use of $y = 900$
	$x = 1.88$	**A1**	
8(i)	$BC^2 = \left(7+\sqrt{5}\right)^2 + \left(7-\sqrt{5}\right)^2$ $= 49 + 14\sqrt{5} + 5 + 49 – 14\sqrt{5} + 5$ $= 108$	**M1**	For use of Pythagoras' theorem and attempt to expand and simplify
	$BC = 6\sqrt{3}$	**A1**	
	Perimeter = $22 + 6\sqrt{5} + 6\sqrt{3}$	**A1**	

Question	Answer	Marks	Guidance
8(ii)	**Either** $\frac{1}{2}\left(4+3\sqrt{5}+11+2\sqrt{5}\right)\left(7+\sqrt{5}\right)$ $=\frac{1}{2}\left(15+5\sqrt{5}\right)\left(7+\sqrt{5}\right)$ $=\frac{1}{2}\left(105+35\sqrt{5}+15\sqrt{5}+25\right)$	**M1**	**Either** For a valid method and attempt to expand out and simplify
	Or $\left(4+3\sqrt{5}\right)\left(7+\sqrt{5}\right)+\frac{1}{2}\left(7+\sqrt{5}\right)\left(7-\sqrt{5}\right)$ $= 28 + 21\sqrt{5} + 4\sqrt{5} + 15 + \frac{1}{2}(49 - 5)$	**M1**	**Or** For a valid method and attempt to expand out and simplify
	Area = $65+25\sqrt{5}$	**A2**	**A1**for each term
9(i)	**Either** $15^2 = 10^2 + 10^2 - 200\cos AOB$ $\cos AOB = -0.125$	**M1**	For use of cosine rule
	$AOB = 1.696$ so 1.70 to 2 dp	**A1**	Must have justification to 2 dp
	Or $\sin\left(\frac{AOB}{2}\right)=\frac{7.5}{10}$ $\frac{AOB}{2}=0.8481$	**M1**	For use of basic trig
	$AOB = 1.696$ so 1.70 to 2 dp	**A1**	

Question	Answer	Marks	Guidance
9(ii)	Angle $DOC = \frac{\pi}{3}$	**B1**	
	Either $AOD = BOC = 0.5\left(2\pi - \frac{\pi}{3} - 1.696\right)$ $AOD = BOC = 1.77$	**M1**	For attempt to get *AOD* or *BOC*
	Arc lengths = 17.7	**M1**	For attempt at arc length using their previous answer
	Perimeter = $15 + 10 + (2 \times 17.7) = 60.4$	**A1**	
	Or Arc *AB* = 17 or Arc *CD* = $\frac{10\pi}{3}$	**M1**	For either arc length
	(20π – arc *AB* – arc *CD*)	**M1**	
	Perimeter = 60.4	**A1**	
9(iii)	**Either** Area of each sector = $\frac{1}{2}10^2(1.770)$	**M1**	For area of sector using their *BOC*
	Area of triangles = $\left(\frac{1}{2} \times 100 \times \sin\frac{\pi}{3}\right) + \left(\frac{1}{2} \times 100 \sin 1.70\right)$	**M1**	For area of one triangle using the sine rule oe
	Total area = 177 + 43.3 + 49.6	**M1**	For plan
	Area = awrt 270	**A1**	
	Or Area of upper segment = $\frac{1}{2}10^2(1.696 - \sin 1.696)$	**M1**	For area of a sector or area of a triangle using the sine rule oe
	Area of lower segment = $\frac{1}{2}10^2\left(\frac{\pi}{3} - \sin\frac{\pi}{3}\right)$	**M1**	For whichever has not been obtained in previous part
	Shaded area = 100π – are of the 2 segments Area = 314.2 – 35.2 – 9.06	**M1**	For plan
	Area = awrt 270	**A1**	

Question	Answer	Marks	Guidance
10	$1.5 = 2 + \cos 3x$ $\cos 3x = -0.5$	**M1**	For correct attempt to find points of intersection
	$3x = \frac{2\pi}{3}, \frac{4\pi}{3}$	**M1**	For dealing with $3x$ correctly
	$x = \frac{2\pi}{9}$ or 40^o	**A1**	
	$x = \frac{4\pi}{9}$ or 80^o	**A1**	
	Either $\int_{\frac{2\pi}{9}}^{\frac{4\pi}{9}} 1.5 - (2 + \cos 3x)\,\mathrm{d}x$	**M1**	For subtraction method – condone omission of or incorrect limits
	$\left[-0.5x - k\sin 3x\right]_{\frac{2\pi}{9}}^{\frac{4\pi}{9}}$	**M1**	For attempt to integrate – condone omission of or incorrect limits
	$\left[-0.5x - \frac{1}{3}\sin 3x\right]_{\frac{2\pi}{9}}^{\frac{4\pi}{9}}$	**A1**	All correct – condone omission of or incorrect limits
	$\left(-\frac{2\pi}{9} + \frac{\sqrt{3}}{6}\right) - \left(-\frac{\pi}{9} - \frac{\sqrt{3}}{6}\right)$	**M1**	Dep for application of limits, must be in radians
	Area = $\frac{\sqrt{3}}{3} - \frac{\pi}{9}$	**A1**	
	Or $\left(1.5 \times \frac{2\pi}{9}\right)$	**M1**	For attempt at rectangle (must include subtraction subsequently)
	$\left[2x + k\sin 3x\right]_{\frac{2\pi}{9}}^{\frac{4\pi}{9}}$	**M1**	For attempt to integrate – condone omission of or incorrect limits
	$\left[2x + \frac{1}{3}\sin 3x\right]_{\frac{2\pi}{9}}^{\frac{4\pi}{9}}$	**A1**	All correct – condone omission of or incorrect limits
	$\left(\left(\frac{8\pi}{9} - \frac{\sqrt{3}}{6}\right) - \left(\frac{4\pi}{9} + \frac{\sqrt{3}}{6}\right)\right)$	**M1**	Dep for application of limits, must be in radians
	Area = $\frac{\sqrt{3}}{3} - \frac{\pi}{9}$	**A1**	

Question	Answer	Marks	Guidance
11(a)(i)	362 880	**B1**	
11(a)(ii)	$7! \times 2$	**B1**	For 7!
	10 080	**B1**	For $7! \times 2$ leading to 10080
11(a)(iii)	Total = $4! \times 4! \times 3! = 3456$	**B3**	**B1** for treating as 4 separate units 4! **B1** for either number of ways of arranging the maths books amongst themselves 4! or the number of ways of arranging the physics books amongst themselves 3!
11(b)(i)	18 564	**B1**	
11(b)(ii)	Total 3738	**B4**	**B1** 4 boys 3150 **B1** 5 boys 560 **B1** 6 boys 28
12	$\frac{dy}{dx} = k\cos\left(x + \frac{\pi}{3}\right) + c$	**M1**	For attempt to integrate
	$\frac{dy}{dx} = -2\cos\left(x + \frac{\pi}{3}\right) + c$	**A1**	All correct, condone omission of $+c$
	$5 = -2\cos\frac{2\pi}{3} + c$	**M1**	Dep for attempt to find c
	$\frac{dy}{dx} = -2\cos\left(x + \frac{\pi}{3}\right) + 4$	**A1**	
	$y = p\sin\left(x + \frac{\pi}{3}\right) \quad (+qx + d)$	**M1**	attempt to integrate a second time to obtain $y = p\sin\left(x + \frac{\pi}{3}\right)$
	$y = -2\sin\left(x + \frac{\pi}{3}\right) + 4x + d$	**A1**	All correct, condone omission of $+d$
	$\frac{5\pi}{3} = -2\sin\frac{2\pi}{3} + \frac{4\pi}{3} + d$	**M1**	Dep for attempt to find a second arbitrary constant
	$y = -2\sin\left(x + \frac{\pi}{3}\right) + 4x + \frac{\pi}{3} + \sqrt{3}$ or $y = -2\sin\left(x + \frac{\pi}{3}\right) + 4x + 2.78$	**A1**	

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CANDIDATE NAME

CENTRE NUMBER

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5120051451

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2019**

2 hours

Candidates answer on the Question Paper.

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Cambridge Assessment International Education

[Turn over

Mathematical Formulae

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Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

Binomial Theorem

$$(a + b)^n = a^n + \binom{n}{1} a^{n-1} b + \binom{n}{2} a^{n-2} b^2 + \ldots + \binom{n}{r} a^{n-r} b^r + \ldots + b^n,$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{(n-r)!r!}$.

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

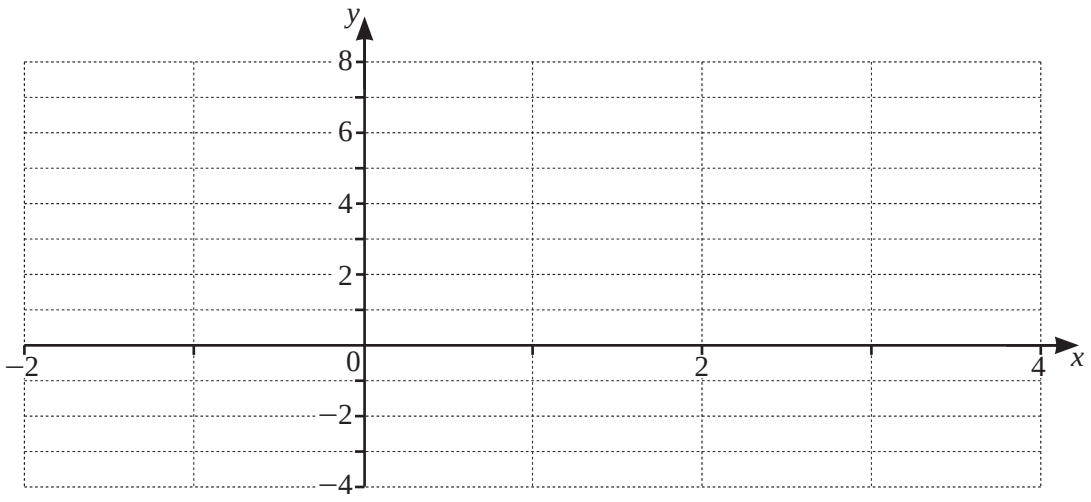
Formulae for ΔABC

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$\Delta = \frac{1}{2} bc \sin A$$

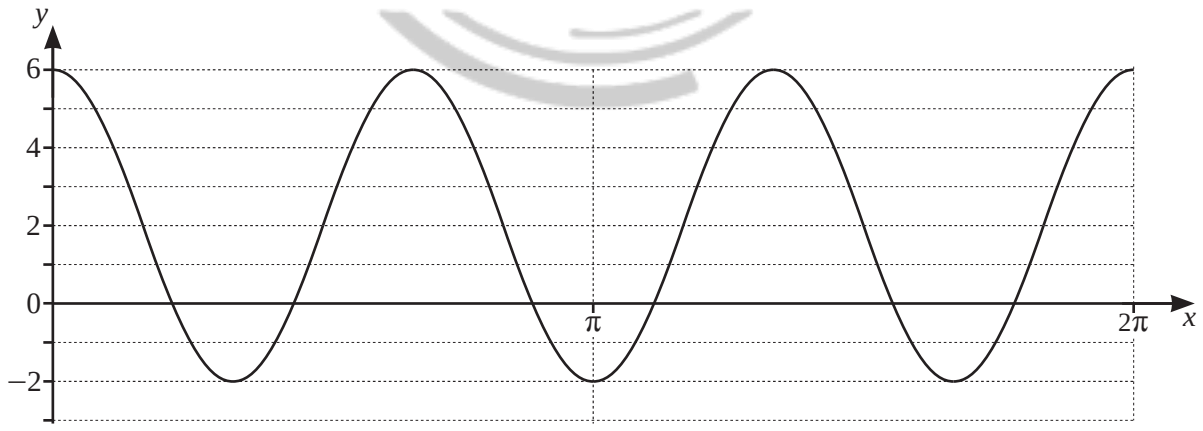
1 **(i)** On the axes below, draw the graph of $y = |2x - 3|$.



[2]

(ii) Solve the equation $7 - |2x - 3| = 0$. [3]

2



The figure shows part of the graph of $y = p + q\cos rx$. Find the value of each of the integers p, q and r.

$p =$ $q =$ $r =$

[3]

[Turn over

3 **(a)** Solve $e^{2x+1} = 3e^{4-3x}$. [3]

(b) Solve $\lg(y-6) + \lg(y+15) = 2$. [5]

4 Do not use a calculator in this question.

Solve the following simultaneous equations, giving your answers for both x and y in the form $a+b\sqrt{2}$, where a and b are integers.

$$2x+y=5$$

$$3x-\sqrt{2}y=7$$ [5]

[Turn over

5 A particle is moving in a straight line such that t seconds after passing a fixed point O its displacement, s m, is given by $s = 3\sin 2t + 4\cos 2t - 4$.

(i) Find expressions for the velocity and acceleration of the particle at time t. [3]

(ii) Find the first time when the particle is instantaneously at rest. [3]

(iii) Find the acceleration of the particle at the time found in **part (ii)**. [2]

6 Do not use a calculator in this question.

The curve $xy = 11x + 5$ cuts the line $y = x + 10$ at the points A and B. The mid-point of AB is the point C. Show that the point C lies on the line $x + y = 11$. [7]

[Turn over

7 **(a)** **(i)** Use the factor theorem to show that $2x-1$ is a factor of $\mathrm{p}(x)$, where $\mathrm{p}(x) = 4x^3+9x-5$. [1]

(ii) Write $\mathrm{p}(x)$ as a product of linear and quadratic factors. [2]

(b) **(i)** Show that $13\tan x\sec x - 4\sin x - 5\sec^2 x = 0$ can be written as $4\sin^3 x + 9\sin x - 5 = 0$. [3]

(ii) Using your answers to **part (a)(ii)** and **part (b)(i)** solve the equation

$$13\tan x\sec x - 4\sin x - 5\sec^2 x = 0 \quad \text{for } 0 < x < 2\pi \text{ radians.}$$ [4]

[Turn over

8 The equation of a curve is given by $y = xe^{-2x}$.

(i) Find $\frac{dy}{dx}$. [3]

(ii) Find the exact coordinates of the stationary point on the curve $y = xe^{-2x}$. [2]

(iii) Find, in terms of e, the equation of the tangent to the curve $y = xe^{-2x}$ at the point $\left(1, \frac{1}{e^2}\right)$. [2]

(iv) Using your answer to **part (i)**, find $\int xe^{-2x} dx$. [3]

[Turn over

9 Given that $\mathbf{A} = \begin{pmatrix} 5 & 2 \\ -9 & -3 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 2 & 1 \\ 6 & 5 \end{pmatrix}$, find

(i) $\mathbf{A}^{-1}$, [2]

(ii) $\mathbf{B}^2$, [2]

(iii) the matrix $\mathbf{C}$, where $\mathbf{B}^{-1}\mathbf{C} + \mathbf{A} = \mathbf{B}$, [3]

(iv) the matrix $\mathbf{D}$, where $\mathbf{B}^{-2}\mathbf{DA} = \mathbf{I}$. [3]

[Turn over

10 **(i)** Expand $(3+x)^4$ evaluating each coefficient. [3]

In the expansion of $\left(x-\frac{p}{x}\right)(3+x)^4$ the coefficient of x is zero.

(ii) Find the value of the constant p. [2]

(iii) Hence find the term independent of x. [1]

(iv) Show that the coefficient of x^2 is 90. [2]

11 A plane, which can travel at a speed of 300 km h^{-1} in still air, heads due north. The plane is blown off course by a wind so that it travels on a bearing of 010° at a speed of 280 km h^{-1}.

(i) Find the speed of the wind. [3]

(ii) Find the direction of the wind as a bearing correct to the nearest degree. [3]

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Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2019**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

MARK SCHEME NOTES

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

M Method marks, awarded for a valid method applied to the problem.

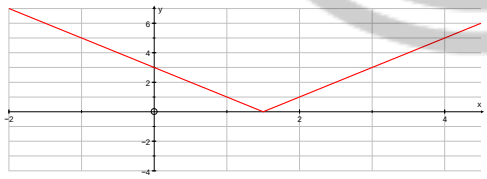
A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.

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

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 M or B mark is dependent on an earlier mark in the scheme.

Abbreviations

awrt	answers which round to
cao	correct answer only
dep	dependent
FT	follow through after error
isw	ignore subsequent working
nfww	not from wrong working
oe	or equivalent
rot	rounded or truncated
SC	Special Case
soi	seen or implied

Question	Answer	Marks	Partial Marks
1(i)		**B2**	**B1** shape **B1** Correct intersection with axes.
1(ii)	$7 = 2x - 3 \rightarrow x = 5$	**B1**	
	Uses $7 = 3 - 2x$ oe	**M1**	
	$x = -2$	**A1**	
2	$p = 2$ $q = 4$ $r = 3$	**B3**	**B1** for each

Question	Answer	Marks	Partial Marks
3(a)	obtain $e^{5x-3} = 3$	**M1**	**OR** Take logs $\rightarrow 2x + 1 = \ln 3 + 4 - 3x$
	take logs correctly $\rightarrow 5x - 3 = \ln 3$	**M1**	**OR** Collect like terms $\rightarrow 5x = 3 + \ln 3$
	$x = \frac{3 + \ln 3}{5}$ or $x = 0.820$	**A1**	
3(b)`	Use of laws of logs $\rightarrow \lg(y - 6)(y + 15) = 2$	**M1**	
	Uses $10^2 = 100$ $\rightarrow [(y - 6)(y + 15)] = 100$	**B1**	
	Obtain correct quadratic $\rightarrow y^2 + 9y - 190 = 0$	**A1**	
	Solve a three term quadratic	**M1**	
	$y = 10$ only	**A1**	
4	Eliminate x or y	**M1**	
	$x = \frac{7 + 5\sqrt{2}}{3 + 2\sqrt{2}}$ or $y = \frac{1}{3 + 2\sqrt{2}}$	**A1**	
	Multiply numerator and denominator by $3 - 2\sqrt{2}$	**M1**	
	$x = 1 + \sqrt{2}$	**A1**	
	$y = 3 - 2\sqrt{2}$	**A1**	
5(i)	Differentiate	**M1**	Obtain $2\cos 2t$ or $-2\sin 2t$
	$v = 6\cos 2t - 8\sin 2t$	**A1**	
	$a = -12\sin 2t - 16\cos 2t$	**A1**	
5(ii)	Equate v to 0 and attempt to solve	**M1**	
	$\tan 2t = 0.75$	**A1**	or $\sin 2t = 0.6$ or $\cos 2t = 0.8$
	$t = 0.32(2)$	**A1**	Must be in radians
5(iii)	Insert value of t into expression for a	**M1**	Radians or degrees
	$a = -20$	**A1**	Must have used radians

Question	Answer	Marks	Partial Marks
6	Eliminate y	**M1**	
	$x^2 - x - 5 = 0$	**A1**	
	Use formula	**M1**	
	$x = \frac{1 \pm \sqrt{21}}{2}$	**A1**	
	$y = \frac{21 \pm \sqrt{21}}{2}$	**A1**	
	Find mid-point	**M1**	$(0.5, 10.5)$
	Show that mid-point lies on $x + y = 11$	**A1**	
7(a)(i)	$f(0.5) = 0.5 + 4.5 - 5 = 0$	**B1**	
7(a)(ii)	Factorise to obtain $2x^2$ and 5	**M1**	
	$(2x-1)(2x^2 + x + 5)$	**A1**	
7(b)(i)	Replace $\tan x$ by $\frac{\sin x}{\cos x}$ and $\sec x$ by $\frac{1}{\cos x}$	**M1**	$13\frac{\sin x}{\cos^2 x} - 4\sin x - \frac{5}{\cos^2 x} = 0$
	Uses $\cos^2 x = 1 - \sin^2 x$	**M1**	$13\sin x - 4\sin x(1 - \sin^2 x) - 5 = 0$
	$4\sin^3 x + 9\sin x - 5 = 0$	**A1**	Completed correctly
7(b)(ii)	$2\sin^2 x + \sin x + 5 = 0$ no real roots	**B1**	Suitable statement seen
	$2\sin x - 1 = 0$	**M1**	Attempt to solve
	$x = \frac{\pi}{6}$	**A1**	
	$x = \frac{5\pi}{6}$	**A1**	
8(i)	$-2e^{-2x}$ seen	**B1**	
	Product rule	**M1**	Clear attempt
	$e^{-2x}(1 - 2x)$	**A1**	

Question	Answer	Marks	Partial Marks
8(ii)	Set $\frac{dy}{dx} = 0$ and attempt to solve	**M1**	Must have two terms
	$\left(\frac{1}{2}, \frac{1}{2e}\right)$	**A1**	
8(iii)	Attempt to find $\frac{dy}{dx}$ at $x = 1$	**M1**	
	$y - \frac{1}{e^2} = \frac{-1}{e^2}(x-1)$ or $y = -\frac{1}{e^2}x + \frac{2}{e^2}$	**A1**	
8(iv)	Integrate **part(i)** $xe^{-2x} = \int\left(-2xe^{-2x} + e^{-2x}\right)dx$	**M1**	
	Integrate e^{-2x} and make $\int xe^{-2x}dx$ the subject	**M1**	
	$\frac{-xe^{-2x}}{2} - \frac{e^{-2x}}{4} + c$	**A1**	
9(i)	$\frac{1}{3}$	**B1**	
	$\times\begin{pmatrix} -3 & -2 \\ 9 & 5 \end{pmatrix}$	**B1**	
9 (ii)	$\mathbf{B}^2 = \begin{pmatrix} 10 & 7 \\ 42 & 31 \end{pmatrix}$	**B2**	Minus one each error
9(iii)	$\mathbf{C} = \mathbf{B}^2 - \mathbf{BA}$	**M1**	
	$\mathbf{BA} = \begin{pmatrix} 1 & 1 \\ -15 & -3 \end{pmatrix}$	**A1**	
	$\mathbf{C} = \begin{pmatrix} 9 & 6 \\ 57 & 34 \end{pmatrix}$	**A1**	
9(iv)	$\mathbf{D} = \mathbf{B}^2\mathbf{A}^{-1}$	**M1**	
	$\mathbf{D} = \frac{1}{3}\begin{pmatrix} 33 & 15 \\ 153 & 71 \end{pmatrix}$	**A2**	Minus one each error
10(i)	$81 + 108x + 54x^2 + 12x^3 + x^4$	**B3**	**B1** for coefficients **B1** for powers **B1** for all Correct

Question	Answer	Marks	Partial Marks
10(ii)	Identify and select two terms in x and equate to zero	**M1**	$81 - 54p = 0$
	$p = 1.5$	**A1**	
10(iii)	Constant term = $-108p = -162$	**A1**	**FT** using *their p*
10(iv)	Correctly identify two terms in x^2	**M1**	x^2 term = $108 - 12p$
	$108 - 18 = 90$	**A1**	
11(i)	Uses correct triangle with v_w opposite 10° Sides of 300 and 280 include 10°	**M1**	
	Use cosine rule	**M1**	$v_w^{\,2} = 300^2 + 280^2 - 2 \times 300 \times 280 \cos 10$
	$v_w = 54.3$	**A1**	
11(ii)	Use sine rule	**M1**	$\frac{280}{\sin\alpha} = \frac{54.3}{\sin 10°}$
	$\alpha = 63°$ or $64°$	**A1**	
	Bearing 117° or 116°	**A1**	