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Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

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* 6 0 1 4 4 8 2 5 3 5 *

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2024**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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INFORMATION

- The total mark for this paper is 80.
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This document has **16** pages.

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 $\binom{n}{r} = \frac{n!}{(n-r)!\,r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2} n(a+l) = \frac{1}{2} n \{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 Show that $\tan\theta + \cot\theta$ can be written as $\sec\theta \operatorname{cosec}\theta$. [3]

2 **(a)** Given that $y = \tan x - x$, find $\frac{dy}{dx}$. Write your answer in terms of $\tan x$. [2]

(b) Hence find $\int_0^{\frac{\pi}{4}} \tan^2 x \, dx$. Give your answer in exact form. [2]

3 **(a)** Solve the equation $8^{\frac{1}{x}} - 2 \times 8^{-\frac{1}{x}} = 1$. [4]

(b) It is given that $(a - \sqrt{3})^2 = b + (3 - b)\sqrt{3}$, where a and b are integers. Find the possible values of a and b. [6]

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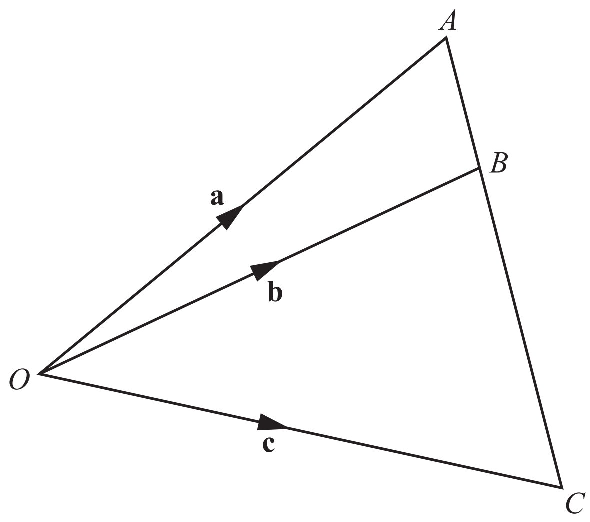
4



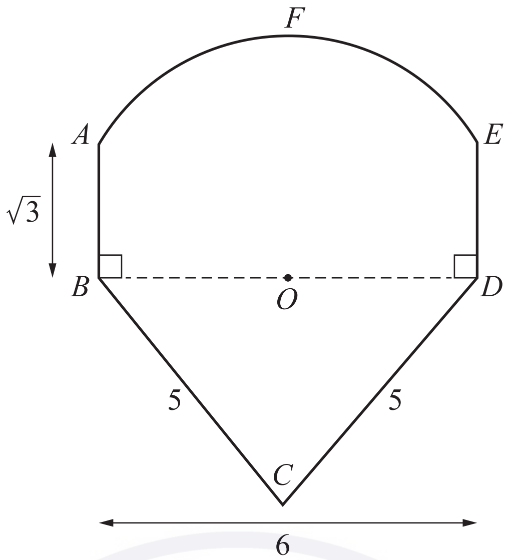
The diagram shows the triangle OAC. The point B lies on AC such that $AB:BC = p:q$, where p and q are constants $(p \neq -q)$.

$$\overrightarrow{OA} = \mathbf{a},\ \overrightarrow{OB} = \mathbf{b} \text{ and } \overrightarrow{OC} = \mathbf{c}.$$

Show that $\mathbf{b} = \dfrac{q\mathbf{a} + p\mathbf{c}}{q+p}$. [5]

5 Given that $\log_a(p+1) + \dfrac{1}{\log_p a} - \log_a(p+2) + \log_a 5 = \log_a 12$, find the value of p. [5]

6 In this question all lengths are in metres.



The diagram shows a shape $ABCDEF$.
AB, BD and DE are three sides of a rectangle.
O is the mid-point of BD.
AFE is an arc of a circle whose centre is O.
$AB = \sqrt{3}$, $BC = CD = 5$ and $BD = 6$.

(a) Find the exact value of the perimeter of the shape, giving your answer in terms of π. [5]

(b) Find the exact value of the area of the shape, giving your answer in terms of π. [3]

7 A curve has equation $y = 2x\cos x$. The normal to the curve at $(\pi, -2\pi)$ meets the x-axis and y-axis at points P and Q. Find the exact area of triangle POQ. [7]

8 A particle moves in a straight line so that its displacement from a fixed point O at time t seconds is x metres, where $x = t^3 + t^2 - t + 8$ and $t \geqslant 0$.

(a) Find the time when the particle changes direction. [3]

(b) Show that the particle is moving towards O when $t = 0$. [3]

(c) Find the total distance travelled by the particle during the first 2 seconds of its motion. [4]

9 A curve has equation $y = x^2 - 8x + c$, where c is a constant.

(a) Find the value of c in each of the following cases.

(i) The curve crosses the x-axis at $x = 2$. [1]

(ii) The minimum value of y is 3. [3]

(b) Find the range of values of c for which y is always greater than 0. [2]

10 **(a)** A class contains 7 girls and 8 boys. A group of 6 is selected from the class. The group must contain at least 3 girls and at least 2 boys. Find the number of different groups that can be selected. [3]

(b) A 5-character code is to be formed from the following characters.

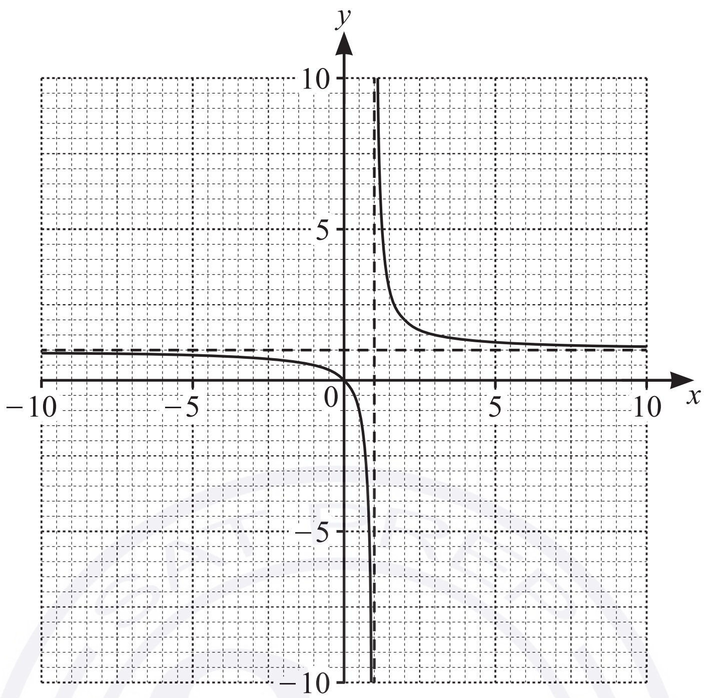
Letters	A	B	C	D	E	F
Numbers	1	2	3			

No character may be used more than once in any code. The characters may be arranged in any order.

Find the number of different codes that can be formed using 4 letters and 1 number. [3]

11 **(a)** $f(x) = \dfrac{x}{x-1}$ for $-10 \leqslant x \leqslant 10$, $x \neq 1$.

The diagram shows the graph of $y = f(x)$.



(i) Use the diagram to explain why f is a function. [1]

(ii) Find $ff(x)$, giving your answer in its simplest form. [2]

(iii) Using your answer to **part (ii)** state the relationship between the functions f and f^{-1}. [1]

(iv) Explain how the diagram shows the relationship between f and f^{-1}. [1]

(b) A function g is defined by $g(x) = \dfrac{x}{x-1}$ for $x \geqslant 2$. Find the range of g. [1]

(c) A function h is defined by $h(x) = \dfrac{2x}{3x+1}$ for the largest possible domain. State the domain of h. [1]

Question 12 is printed on the next page.

12 Two arithmetic progressions, A and B, each have 100 terms. Their terms are denoted by $a_1, a_2, a_3, a_4, \dots a_{100}$ and $b_1, b_2, b_3, b_4, \dots b_{100}$ respectively.

It is given that $a_1 = b_{100} = 1$ and $a_{100} = b_1 = 298$.

(a) Find n such that $a_n - b_n = 45$. [6]

(b) Find the smallest m such that $a_m > 2b_m$. [3]

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

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1 Solve the following simultaneous equations.

$$\frac{y}{x} = \frac{3}{2}$$

$$\frac{y^4}{x^5} = \frac{27}{16}$$ [3]

2 Variables x and y are related by the equation $y = x\sqrt{1+2x}$.

(a) Find $\frac{\mathrm{d}y}{\mathrm{d}x}$. [3]

(b) It is given that when $y = 12$, $x = 4$. Find the approximate change in x when y increases from 12 by the small amount 0.06. [3]

(c) Find the x-coordinate of the stationary point on the curve $y = x\sqrt{1+2x}$. [2]

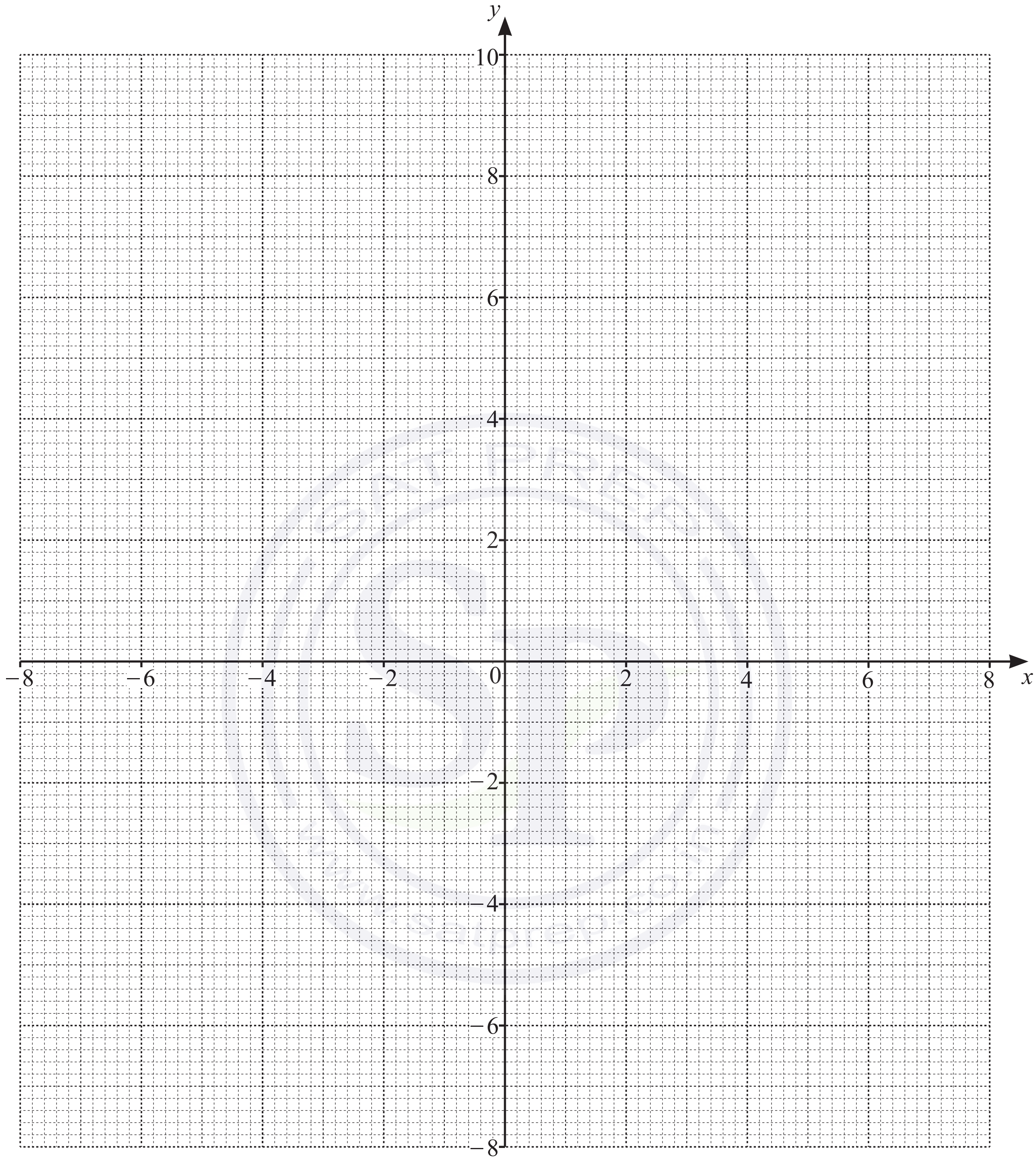
3 **DO NOT USE A CALCULATOR IN THIS QUESTION.**

The polynomial p is defined by $p(x) = ax^3 - 3x^2 - 3x + b$, where a and b are constants.

(a) Given that $x = 2$ and $x = -1$ are roots of the equation $p(x) = 0$, find a and b. [3]

(b) Solve the equation $p(x) = 0$. [2]

4 Use a graphical method to solve the inequality $|2x-8|>4$. [5]



5 Solve the following equations.

(a) $\log_2 x^2 + \log_{16} x = 18$ [4]

(b) $e^{2x+1} - 10e^{-2x-1} = 3$ [4]

6 **DO NOT USE A CALCULATOR IN THIS QUESTION.**

Write $(5-\sqrt{3})(\sqrt{6}+\sqrt{2})^{-2}$ in the form $a+b\sqrt{3}$, where a and b are constants. [5]

7 A class of 10 students includes Abby and Ben.

(a) A group of 5 students is to be selected from the class. Find the number of possible groups in the following cases.

(i) There are no restrictions. [1]

(ii) The group includes both Abby and Ben. [2]

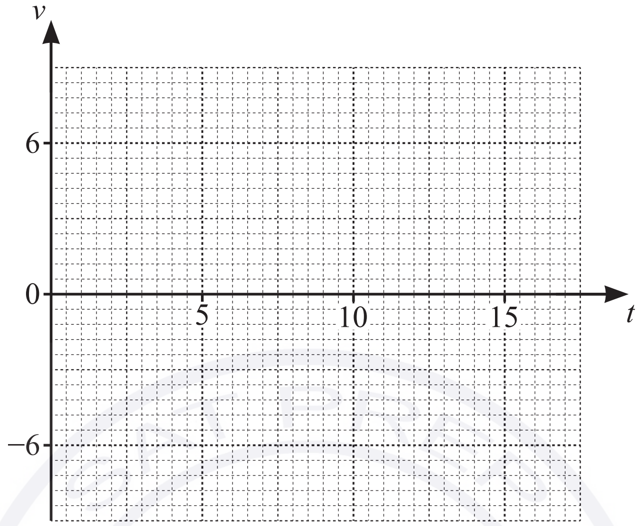
(iii) The group includes either Abby or Ben, but not both. [2]

(b) All 10 students are arranged in a line. How many arrangements are possible if there are exactly three students between Abby and Ben? [3]

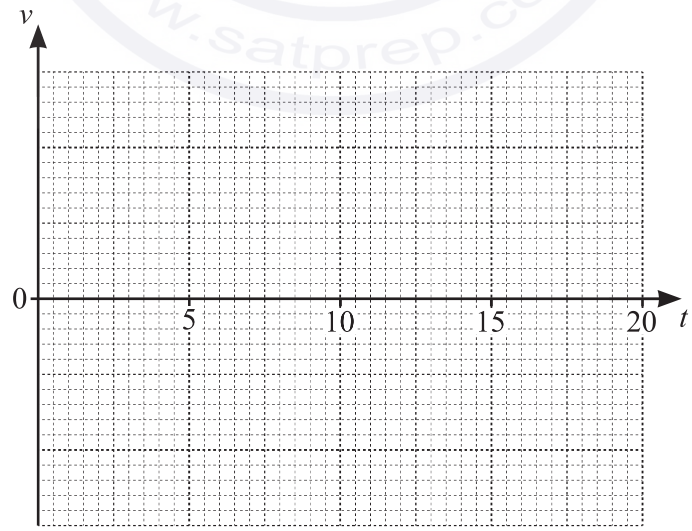
8 Solve the equation $\cot^2 2\theta + 3\,\text{cosec}\, 2\theta = 9$ for $-90° \leqslant \theta \leqslant 90°$. [6]

9 In this question time is measured in seconds.

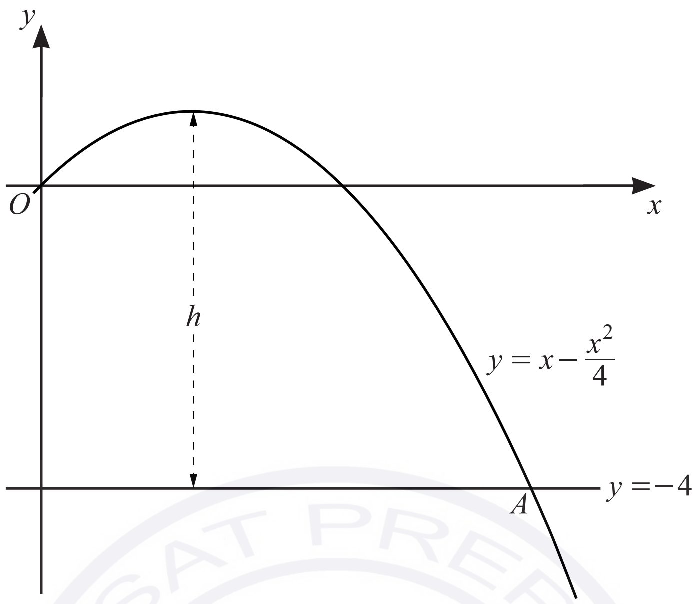
(a) A particle is moving in a straight line with constant velocity of $6\,\text{ms}^{-1}$. At time $t = 0$, it passes a fixed point A. At time $t = 5$ it suddenly changes direction and moves with a different constant velocity along the same straight line. It passes the point A again at time $t = 15$. Sketch the velocity–time graph for the motion. [3]



(b) Another particle is moving in a straight line with constant acceleration. At time $t = 0$ it passes a fixed point B with velocity $-8\,\text{ms}^{-1}$. It passes the point B again at time $t = 20$. Sketch the velocity–time graph for the motion. [3]



10 The diagram shows part of the curve $y = x - \frac{x^2}{4}$ and the line $y = -4$. The curve and the line intersect at the point A.



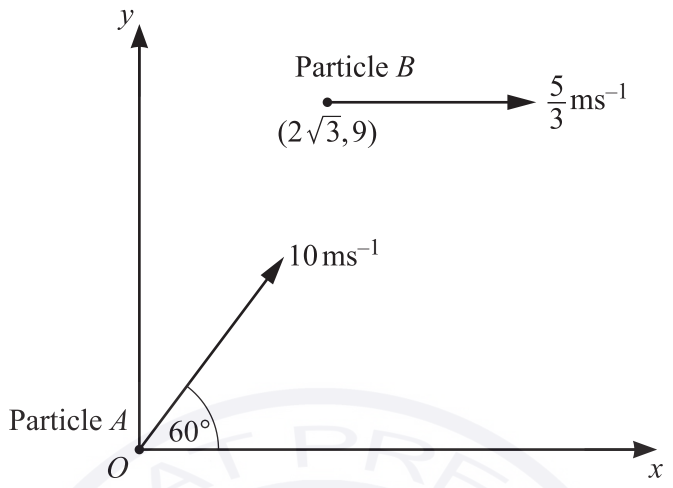
(a) The maximum point on the curve is at a perpendicular distance h from the line $y = -4$. Find the value of h. [4]

(b) Find the exact x-coordinate of A. [3]

(c) Find the acute angle between the tangent to the curve at A and the line $y = -4$. [4]

11 In this question **i** is a unit vector in the positive x-direction and **j** is a unit vector in the positive y-direction. Time is in seconds and distances are in metres.

The diagram shows the initial positions and velocities of two particles, A and B, that move in the x-y plane.



Particle A starts from the origin O at time $t = 0$. It moves with constant speed $10\,\text{ms}^{-1}$ in the direction 60° above the x-axis.

(a) Find the exact values of the components of the velocity of particle A in the x-direction and the y-direction. [2]

(b) Find, in terms of t, the position vector of particle A at time t. [1]

Particle B starts from the point $(2\sqrt{3}, 9)$ at time $t = 0$. It moves with constant speed $\frac{5}{3}\text{ms}^{-1}$ parallel to the positive x-axis.

(c) Find, in terms of t, the position vector of particle B at time t. [2]

(d) Hence show that the particles collide. [4]

Question 12 is printed on the next page.

12 A metal tank is in the shape of a cuboid with a square base of side x m and an open top. The tank has a volume of $5\,\text{m}^3$. Given that x can vary, and that the area of the metal used to make the tank is a minimum, find the dimensions of the tank. [6]

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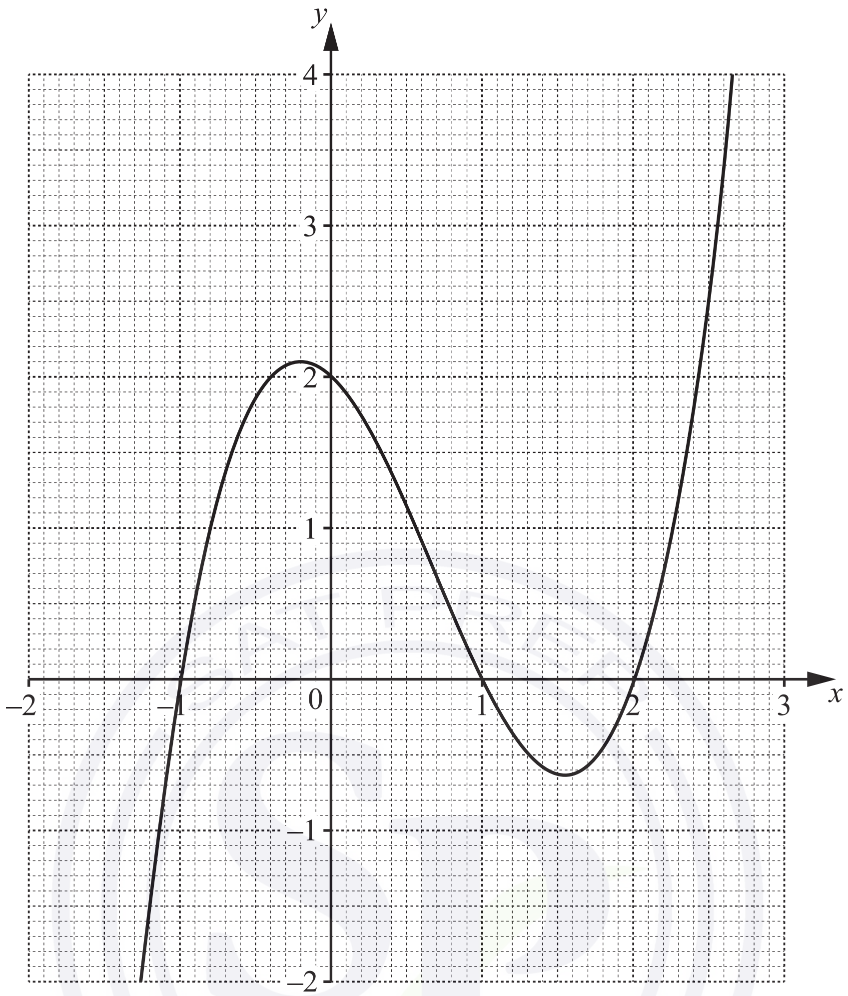
1



The diagram shows the graph of $y = (x+1)(x-1)(x-2)$. Use the graph to solve the inequality $(x+1)(x-1)(x-2) < 1$. [3]

2 The function f is defined by $f(x) = 1 - 4x - x^2$ for all real values of x.

(a) Write $f(x)$ in the form $a - (x+b)^2$, where a and b are constants. [2]

(b) Find the range of f. [1]

The function g is defined by $g(x) = 1 - 4x - x^2$ for $x \geqslant k$, where k is a constant.

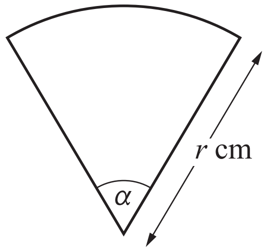
(c) State the least possible value of k such that g has an inverse. [1]

(d) Using your value of k, find $g^{-1}(x)$, stating its domain and range. [5]

3 **(a)** Show that $(2\tan\theta + \sec\theta)(2\tan\theta - \sec\theta) = 3\tan^2\theta - 1$. [2]

(b) Hence solve the equation $(2\tan\theta + \sec\theta)(2\tan\theta - \sec\theta) = 1$ for $0° \leqslant \theta \leqslant 180°$. [4]

4 The diagram shows a design for a logo. The logo is a sector of a circle, radius r cm, with angle α radians.



The area of the logo is 9 cm^2.

(a) Show that the perimeter, P cm, of the logo is given by

$$P = 2r + \frac{18}{r}.$$ [3]

(b) Given that r can vary, find the stationary value of P and determine its nature. [5]

5 The tangent to the curve $y = \dfrac{\sqrt{x+1}}{x}$ at the point where $x = 3$ meets the line $y = x - 16$ at the point A. Find the coordinates of A. [8]

6 **(a)** Find $\int \frac{1}{\sqrt{3x+2}}\,\mathrm{d}x$. [2]

(b) Find, in terms of a, $\int_{0.5}^{a} \mathrm{e}^{(1-2x)}\,\mathrm{d}x$. [3]

7 **(a)** In the expansion of $\left(x+x^2\right)^8$ in ascending powers of x, the 3rd and 6th terms are equal.

Find the value of x. [3]

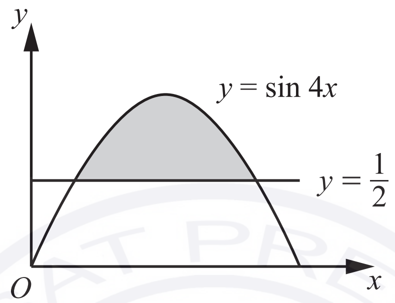
(b) In the expansion of $\left(x+\frac{2}{x}\right)^n$ in decreasing powers of x, the 6th term is a constant.

(i) Find the value of the positive integer n. [2]

(ii) Find the value of the 6th term. [2]

8 **(a)** Solve the equation $\sin 4x = \frac{1}{2}$ for $0 \leqslant x \leqslant \frac{\pi}{4}$, giving your answers in terms of π. [2]

(b)



The diagram shows parts of the graphs of $y = \sin 4x$ and $y = \frac{1}{2}$.

Find the exact area of the shaded region enclosed by the curve and the line. [5]

9 DO NOT USE A CALCULATOR IN THIS QUESTION.

Write $\frac{16+11\sqrt{10}}{2+\sqrt{10}}+1$ in the form $p+q\sqrt{10}$, where p and q are integers. [4]

10 **(a)** Suzma is training for a marathon. In the first week she runs 10 km. Then each week she runs a distance that is 10% greater than the week before.

The total distance that Suzma has run by the end of n whole weeks is more than 200 km. Find the smallest possible value of n. [4]

(b) A geometric progression has 1st term a and common ratio r, where $a \neq 0$ and $r \neq 1$. The 1st, 2nd and 3rd terms of the geometric progression are the 1st, 3rd and 7th terms of an arithmetic progression. Find the value of r. [4]

11 **(a)** There are 3 girls and 2 boys standing in a straight line. Find the number of possible orders in each of the following cases.

(i) No girls are next to each other. [2]

(ii) The 2 boys are not next to each other. [2]

(b) 12 people, including Anjie and Bubay, are divided into 3 groups of 4 people. Anjie and Bubay must not be in the same group.

Find the number of ways in which the 3 groups can be selected. [2]

12 A particle moves in a straight line. Its velocity, $v\,\text{ms}^{-1}$, at time t seconds is given by

$$v = \cos t - \sin t.$$

(a) Find the acceleration, $a\,\text{ms}^{-2}$, when $t = \dfrac{\pi}{3}$. [2]

The displacement of the particle from a fixed point O at time t is s metres. The particle passes through O when $t = 0$.

(b) Find the displacement at the time when the particle first changes direction after passing through O. [6]

(c) Find an expression for a in terms of s. [1]

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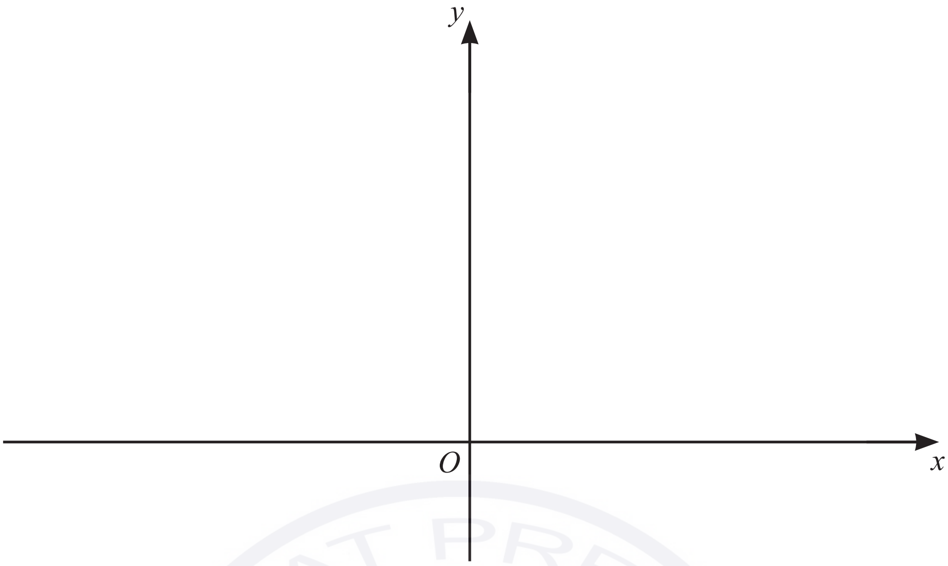
$$\Delta = \frac{1}{2}bc\sin A$$

1 **(a)** On the axes, sketch the graph of $y = |4x - 6|$, showing the points where the graph meets the axes. [2]



(b) Solve the equation $|4x - 6| = |2x|$. [3]

2 **(a)** Write $3+4x-2x^2$ in the form $a+b(x+c)^2$, where a, b and c are integers. [3]

(b) Hence write down the range of the function $f(x)=3+4x-2x^2$, where $x \in \mathbb{R}$. [1]

3 Use algebra to show that the equation $5x(x-3)=5x-26$ has no real solutions. [3]

4 DO NOT USE A CALCULATOR IN THIS QUESTION.

(a) Find the exact distance between the two points where the curve $9(x-1)^2+4(y-3)^2=36$ cuts the y-axis. [4]

(b) Find the coordinates of the points where the curve with equation $2x^2+83xy=x^3y-20x$ intersects the curve with equation $y=\frac{1}{x}$. Give each of your answers in the form $a+b\sqrt{c}$, where a and b are rational and c is the smallest integer possible. [6]

5 There are 3 women, 2 men and 4 children in a choir.

(a) The choir stands in a single straight line.

(i) Find the number of possible arrangements if the first person and last person are both women. [2]

(ii) Find the number of possible arrangements if all the children stand next to each other. [2]

(b) Four of the choir are selected to sing in a group.

(i) Find the number of different selections if no man is chosen. [2]

(ii) Find the number of different selections if at least 2 women are chosen. [2]

6 Variables x and y are such that $y = \cos x \sin^2 x$. Use differentiation to find the approximate change in y as x increases from 3 to $3 + h$, where h is small. [5]

7 It is given that $y = mx^2 + \frac{x}{2} + n$, where m and n are non-zero constants. It is also given that $3\left(\frac{d^2y}{dx^2}\right) = \left(\frac{dy}{dx}\right)^2 - y$ for all values of x. Find the values of m and n. [4]

8 **(a)** In an arithmetic progression, the sum of the first 30 terms is -1065.
The sum of the **next** 20 terms is -2210.
Find the first term and the common difference. [5]

(b) A geometric progression is such that the first term is 4 and the sum of the first three terms is 7.

Find the two possible values of the common ratio and find the sum to infinity for the convergent progression. [5]

9 The functions f and g are defined by

$$f(x) = \frac{3x^2}{4x-1} \quad \text{for } x < 0$$
$$g(x) = \frac{1}{x^2} \quad \text{for } x < 0.$$

(a) Explain why the function fg does **not** exist. [1]

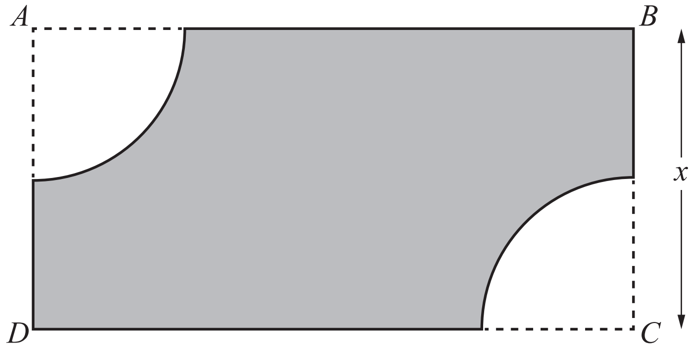
(b) Given that the function gf does exist, find and simplify an expression for $gf(x)$. [2]

(c) Show that $f^{-1}(x)$ can be written as $\frac{px - \sqrt{x(qx+r)}}{3}$ where p, q and r are integers. [4]

10 **(a)** Show that $(\tan x + \sec x)^2$ can be written as $\dfrac{1+\sin x}{1-\sin x}$. [4]

(b) Hence solve the equation $(\tan 3\theta + \sec 3\theta)^2 = 6$ for $0° \leqslant \theta \leqslant 180°$. [4]

11 In this question all lengths are in centimetres.



The diagram shows a rectangle $ABCD$ with $BC = x$.
The area of the rectangle is $400\,\text{cm}^2$.

Two identical quarter-circles of radius $\frac{x}{2}$, with centres A and C, are removed from the rectangle to make the shaded shape.

Given that x can vary, find the value of x that gives the minimum value of the perimeter of the shaded shape and hence find this minimum value. [7]

Continuation of working space for Question 11.

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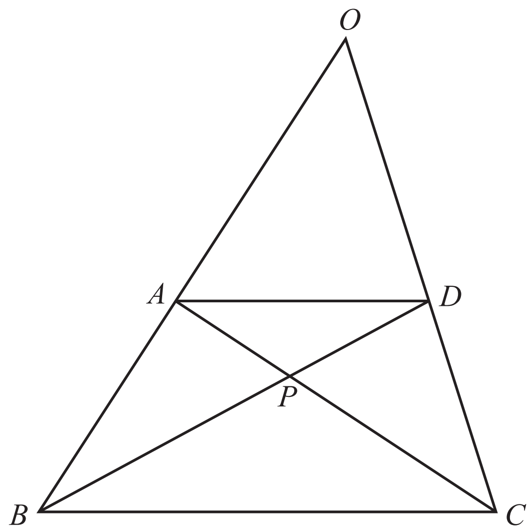
12



The diagram shows a triangle OBC.
$OA : OB = 4 : 7$ and $OD : OC = 4 : 7$.

$$\overrightarrow{OB} = \mathbf{b} \text{ and } \overrightarrow{OC} = \mathbf{c}$$

The point P is the point of intersection of AC and BD such that $\overrightarrow{AP} = \lambda\overrightarrow{AC}$ and $\overrightarrow{BP} = \mu\overrightarrow{BD}$ where λ and μ are scalars.

(a) Find two expressions for $\overrightarrow{OP}$, each in terms of **b**, **c** and a scalar, and hence show that P divides both AC and DB in the ratio 4 : 7. [7]

(b) The point Q is such that $\overrightarrow{OQ} = \frac{2}{7}\mathbf{b} + \frac{2}{7}\mathbf{c}$.

Use a vector method to show that O, Q and P are collinear. Justify your answer. [2]

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CANDIDATE NAME

CENTRE NUMBER

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* 6 3 8 4 3 5 3 9 0 0 *

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2024**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (DE/SG) 332420/2

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
$$\sec^2 A = 1 + \tan^2 A$$
$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

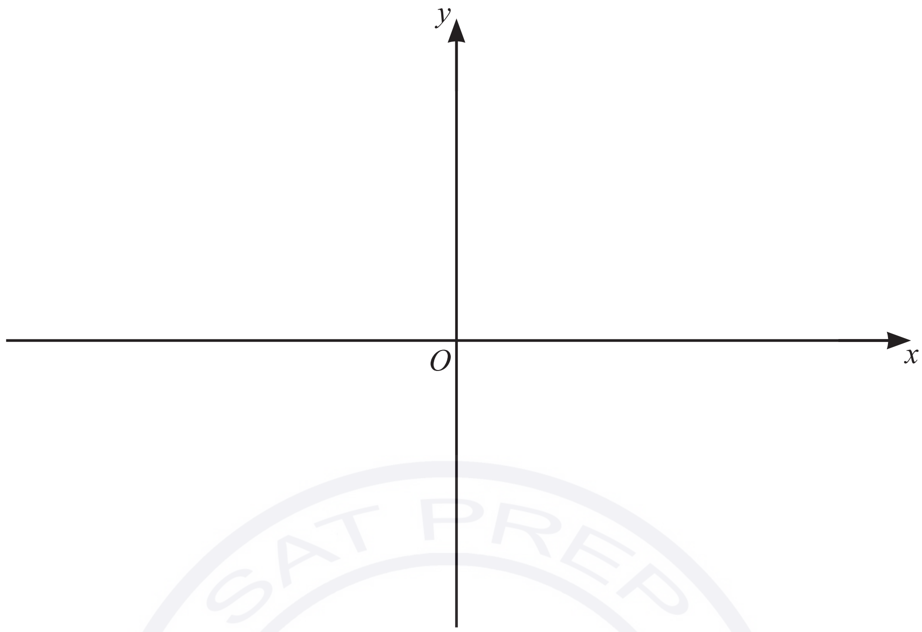
Formulae for ΔABC

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

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

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

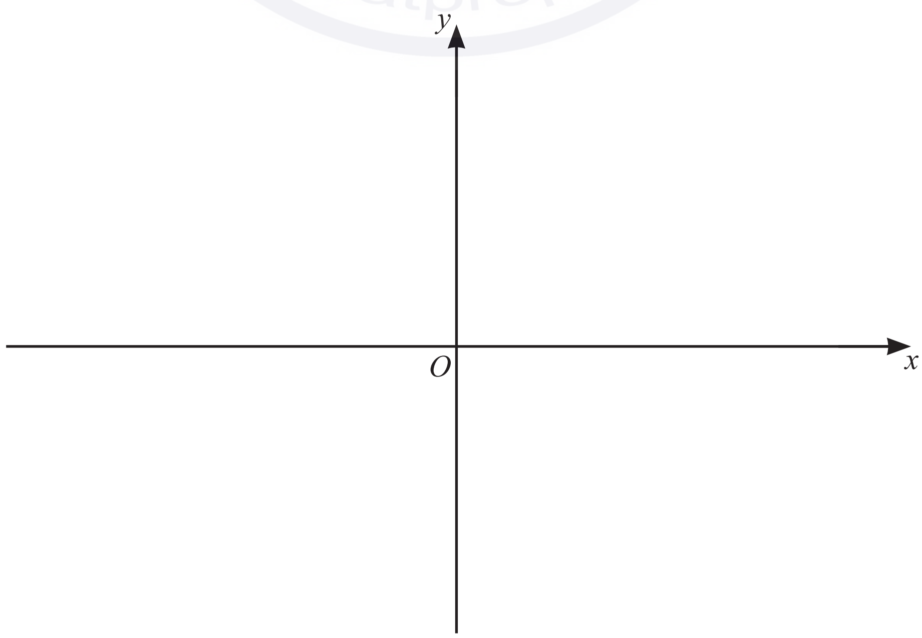
1 **(a)** On the axes, sketch the graph of $y=(2x-5)(x+3)(1-x)$, stating the intercepts with the coordinate axes. [3]



(b) Hence

(i) solve the inequality $(2x-5)(x+3)(1-x) \leqslant 0$ [2]

(ii) on the axes below, sketch the graph of $y=|(2x-5)(x+3)(1-x)|$. [1]



2 **(a)** Evaluate $\int_{\frac{\pi}{3}}^{\frac{\pi}{2}} \cos\frac{x}{4}\,dx$. You must show all your working. [4]

(b) Find $\int\left(\frac{1}{4x-3}+\frac{1}{x^3}\right)dx$. [3]

3 **(a)** Determine whether the equation $\frac{(4x+1)(3x+2)}{5x-3} = x+1$ has two distinct real roots, two equal roots or no real roots. [4]

(b) Solve the equation $\frac{12}{\sqrt[3]{x}} - \sqrt[3]{x} = 4$. [4]

4 The polynomial p is such that $p(x) = 6x^3 + x^2 - 12x + 5$.

(a) Find the remainder when $p(x)$ is divided by $x - 2$. [1]

(b) **(i)** Show that $2x - 1$ is a factor of $p(x)$. [1]

(ii) Hence write $p(x)$ as a product of linear factors. [3]

(iii) Hence solve the equation $6\sin^3\theta + \sin^2\theta - 12\sin\theta + 5 = 0$ for $0° \leqslant \theta \leqslant 90°$. [2]

5 A curve has equation $y = 5e^{2x-1} + e$. The tangent to the curve at the point where $x = 1$ cuts the x-axis at the point P.

Find the equation of the tangent in the form $y = mx + c$, where m and c are exact values, and hence find the x-coordinate of P. [6]

6 **(a)** Show that $\sin^3 x\left(\dfrac{\operatorname{cosec} x}{\cot x}\right)$ can be written as $\sin^2 x \tan x$. [3]

(b) Solve the equation $\cos^2 x \tan x - \dfrac{1}{2}\tan x = 0$ for $-\pi < x < \pi$. [5]

7 Find the number of different ways the 9 letters of the word POLYMATHS can be arranged when

(a) the O and A are **not** next to each other [2]

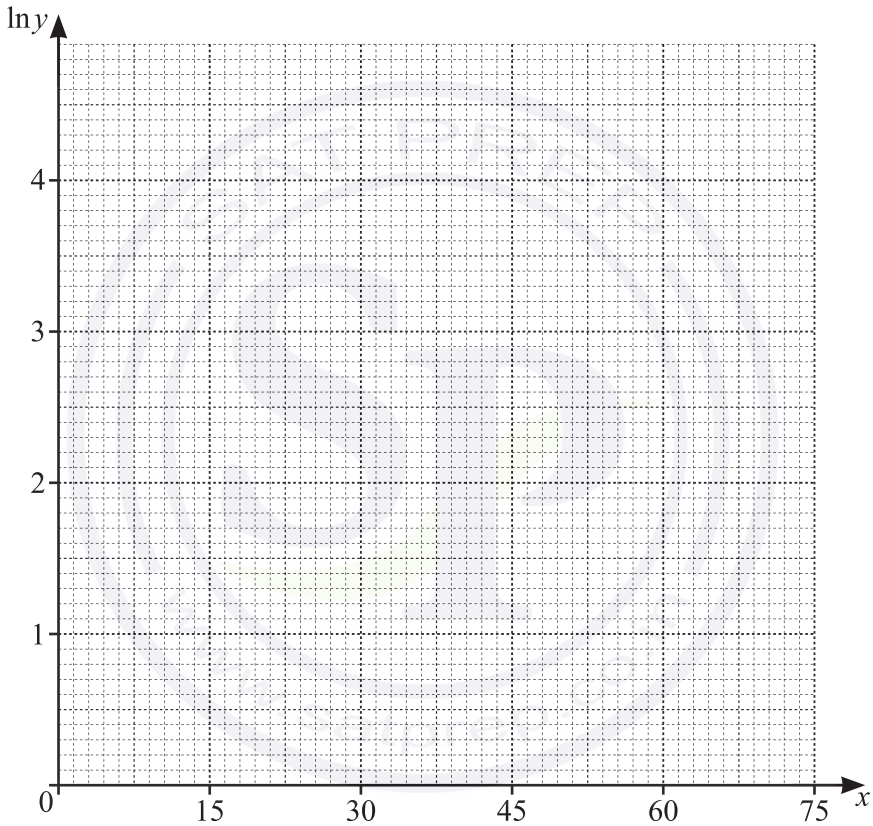
(b) the letters MATHS are together in this order. [2]

8 An experiment was carried out and values of y for certain values of x were recorded. The table shows the values recorded.

x	15	30	45	60	75
y	10	13	22	35	50

The relationship between y and x is modelled by $y = Ae^{kx}$, where A and k are constants.

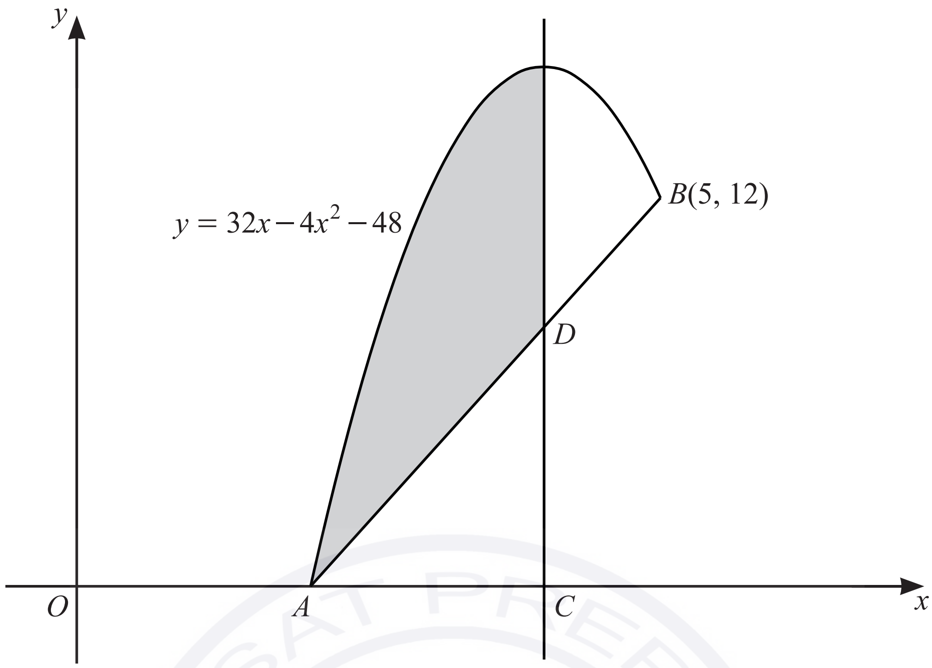
(a) Draw a straight line graph for $\ln y$ against x. [2]



(b) Find the equation of the line in **part (a)** and hence find the values of A and k. Give each value correct to 1 significant figure. [5]

(c) Find the value of x for which $y = 17$. [2]

9



The diagram shows part of the curve $y = 32x - 4x^2 - 48$ and the line AB.
The curve and the line AB meet the x-axis at A and meet again at the point $B(5, 12)$.
The line CD extended is parallel to the y-axis and passes through the maximum point of the curve.
Find the area of the shaded region. [9]

Continuation of working space for Question 9.

10 The functions f and fg are defined by

$$f(x) = e^{x^2+3} \quad \text{for} \quad x < 0$$

$$fg(x) = e^{2x} \quad \text{for} \quad x > \frac{3}{2}.$$

(a) Explain why f^{-1} exists. [1]

(b) Find an expression for $f^{-1}(x)$ and state the domain and range of f^{-1}. [5]

(c) Hence find and simplify an expression for $g(x)$. [2]

11 In the binomial expansion of $\left(2+\frac{x}{2}\right)^n$, the first three terms in increasing powers of x are $b+abx+\frac{9}{8}abx^2$. Find the values of the constants n, a and b. [8]

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9965890960

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2024**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
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- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages.

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

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

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

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

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$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

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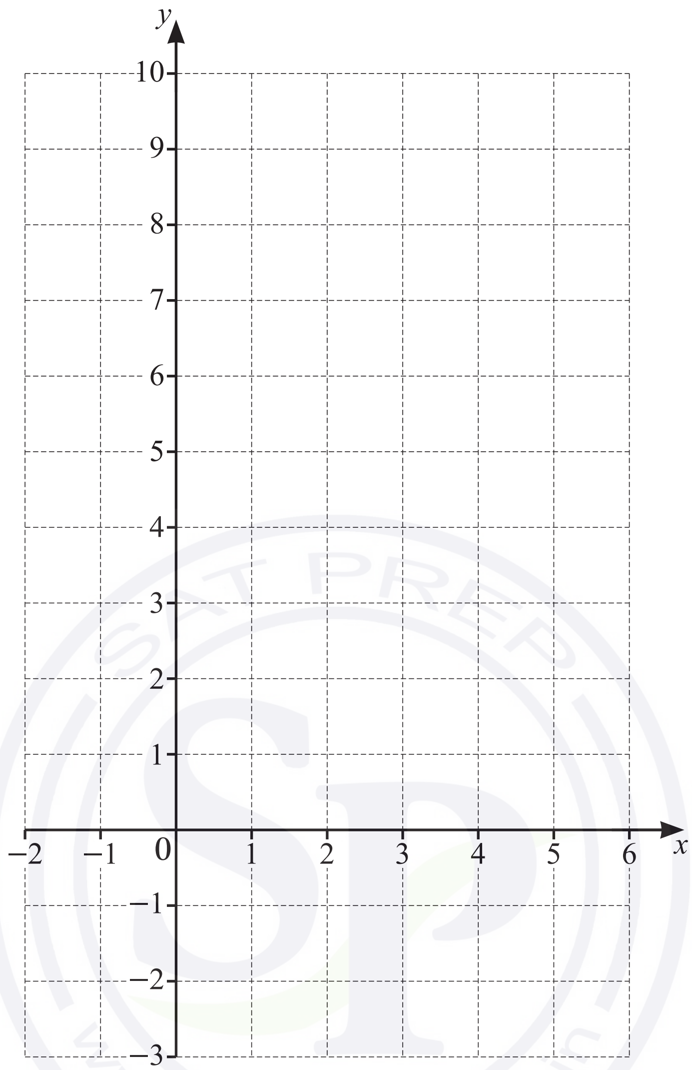
$$a^2 = b^2 + c^2 - 2bc\cos A$$

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

1 The point A has coordinates (1, 4) and the point B has coordinates (5, 6). The perpendicular bisector of AB intersects the x-axis at the point C and the y-axis at the point D. Given that O is the origin, find the area of triangle OCD. [5]

2 Given that the equation $kx^2 + (2k-1)x + k + 1 = 0$ has no real roots, find the set of possible values of k. [4]

3 (a)



Draw the graphs of $y = |2x - 5|$ and $y = |4 - x|$ for $-2 \leqslant x \leqslant 6$. [4]

(b) Use your graphs to solve the inequality $|4 - x| \leqslant |2x - 5|$. [2]

4 **(a)** Find and simplify the term independent of x in the expansion of $\left(x^2 - \frac{1}{2x^3}\right)^{10}$. [2]

(b) **DO NOT USE A CALCULATOR IN THIS PART OF THE QUESTION.**

(i) Use the binomial theorem to show that $\left(1+2\sqrt{2}\right)^4 - \left(1-2\sqrt{2}\right)^4 = k\sqrt{2}$, where k is an integer to be found. [4]

(ii) Hence write $\frac{\left(1+2\sqrt{2}\right)^4 - \left(1-2\sqrt{2}\right)^4}{1+\sqrt{2}}$ in the form $a+b\sqrt{2}$, where a and b are integers. [2]

5 **(a)** The function f is defined by $\mathrm{f}(x) = \dfrac{1+2\sin^2 x}{\cos^2 x}$ for $-\dfrac{\pi}{2} < x < \dfrac{\pi}{2}$.

(i) Show that $\mathrm{f}(x)$ can be written as $a\tan^2 x + b$, where a and b are integers. [2]

(ii) Hence solve the equation $\mathrm{f}(x) = 4$. [3]

(iii) Hence also find the gradient of the curve $y = \mathrm{f}(x)$ at each of the points where $y = 4$. [4]

(b) Solve the equation $50\cos^2\theta = 5\sin\theta + 47$ for $0° \leqslant \theta \leqslant 360°$. [5]

6 DO NOT USE A CALCULATOR IN THIS QUESTION.

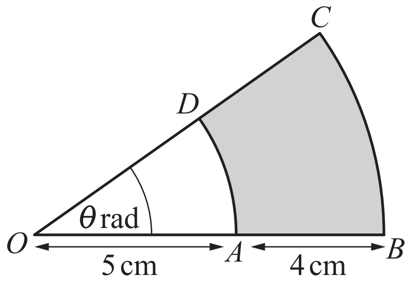
(a) Given that $x-3$ and $x+1$ are both factors of $2x^3-3x^2-8x-3$, solve the equation $2x^3-3x^2-8x-3=0$. [2]

(b) The polynomial $p(x)=x^3+ax^2+bx+c$, where a, b and c are constants, has remainder -5 when divided by $x-1$. The curve $y=p(x)$ has stationary points at $x=\frac{4}{3}$ and $x=2$.

(i) Find the values of a, b and c. [7]

(ii) Hence use the second derivative test to show that the stationary point at $x=2$ is a minimum. [2]

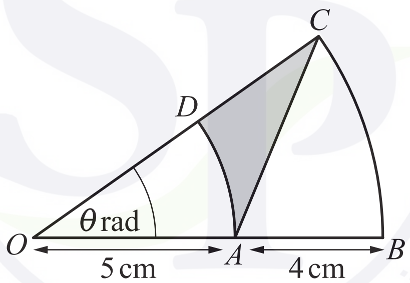
7



In the diagram, AD and BC are arcs of circles with common centre O.
ODC and OAB are straight lines with $OA = 5\,\text{cm}$ and $AB = 4\,\text{cm}$. Angle $BOC = \theta$ radians.
The area of the shaded region $ABCD$ is $4\pi\,\text{cm}^2$.

(a) Find θ. [3]

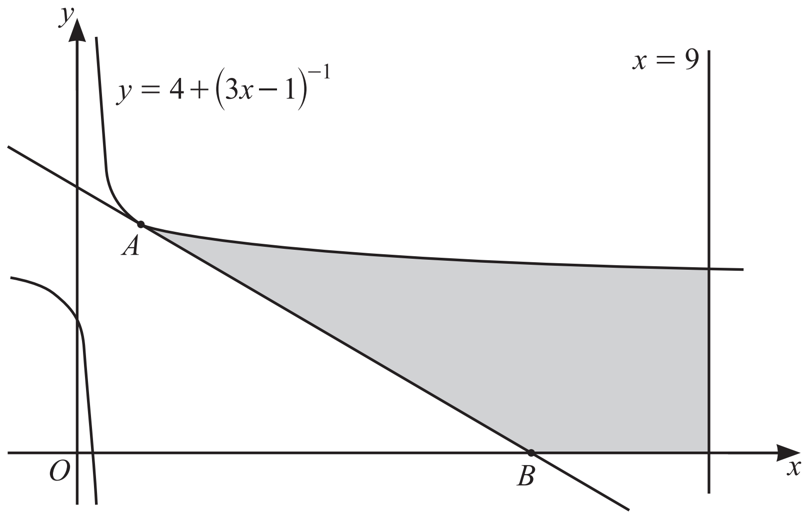
(b)



The straight line AC is added to the diagram and the region ACD is now shaded.
Find the perimeter of the shaded region ACD. [5]

8 A curve is such that $\frac{d^2y}{dx^2} = \cos\left(4x - \frac{\pi}{4}\right)$. Given that $\frac{dy}{dx} = \frac{3}{4}$ at the point $\left(\frac{3\pi}{16}, \frac{\pi}{4}\right)$ on the curve, find the equation of the curve. [7]

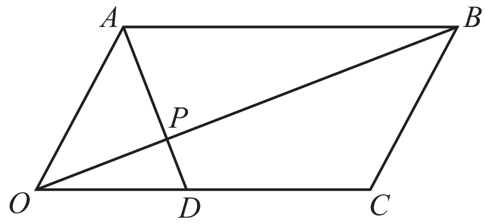
9



The diagram shows a sketch of part of the curve $y = 4 + (3x - 1)^{-1}$ and the line $x = 9$.
The point A has x-coordinate 1. The tangent to the curve at A meets the x-axis at the point B.
Find the area of the shaded region. [10]

Question 10 is printed on the next page.

10



The diagram shows a parallelogram *OABC*. The point *D* divides the line *OC* in the ratio 2 : 3.

$$\overrightarrow{OA} = \mathbf{a} \quad \text{and} \quad \overrightarrow{OC} = \mathbf{c}$$

The point *P* lies on *AD* such that $\overrightarrow{OP} = \lambda\overrightarrow{OB}$ and $\overrightarrow{AP} = \mu\overrightarrow{AD}$, where λ and μ are scalars.

Find two expressions for $\overrightarrow{OP}$, each in terms of **a**, **c** and a scalar, and hence show that *P* divides both *DA* and *OB* in the ratio *m* : *n*, where *m* and *n* are integers to be found. [7]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1019294221

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **February/March 2024**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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INFORMATION

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- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

DC (PQ/JG) 327627/2

Mathematical Formulae

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

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

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$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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Identities

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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 **(a)** Solve the equation $2|8-4x|+5=25$. [3]

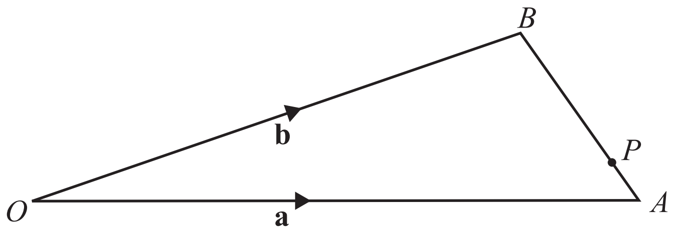
(b) Solve the inequality $16x-5x^2-3<\frac{57-9x}{6}$. [4]

2 DO NOT USE A CALCULATOR IN THIS QUESTION.
In this question all lengths are in centimetres.

The diagram shows two similar triangles.
The height of the smaller triangle is $1+7\sqrt{5}$ and the height of the larger triangle is $a+b\sqrt{5}$, where a and b are integers.

Find the values of a and b. [4]

3 **(a)**



The diagram shows a triangle OAB. The point P lies on AB. The ratio $AP:PB$ is $1:3$.
Given that $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$, find an expression for $\overrightarrow{OP}$ in terms of $\mathbf{a}$ and $\mathbf{b}$. Simplify your answer. [2]

(b) Vector $\mathbf{q}$ has magnitude $12\sqrt{5}$ and direction $\begin{pmatrix} 6 \\ -3 \end{pmatrix}$.

Vector $\mathbf{r}$ has magnitude $15\sqrt{2}$ and direction $\begin{pmatrix} -5 \\ 5 \end{pmatrix}$.

Find the unit vector in the direction of $\mathbf{q} + \mathbf{r}$. [6]

4 **(a)** **(i)** Given that $y = 3\sin^2 x + \cos x$, show that $y + \cot x \frac{dy}{dx} = k(1 + \cos^2 x)$, where k is an integer. [4]

(ii) Using your value of k, solve the equation $k(1 + \cos^2 x) = 4$ for $-\pi \leqslant x \leqslant \pi$. [4]

(b) **(i)** Differentiate $y = \tan\left(x - \sqrt{x}\right)$ with respect to x. [2]

(ii) Hence find $\displaystyle\int \frac{2\sqrt{x} - 1}{\sqrt{x}\cos^2\left(x - \sqrt{x}\right)}\,\mathrm{d}x$. [2]

5 Variables x and y are related by the equation $y = \dfrac{x}{\ln 3x}$. Use differentiation to find the approximate change in y when x increases from 1 to $1 + h$, where h is small. [4]

6 Find the exact area of the region enclosed by the curve $y = e^{2-4x}$, the x-axis, the line $x = -0.25$ and the line $x = 0.5$. [4]

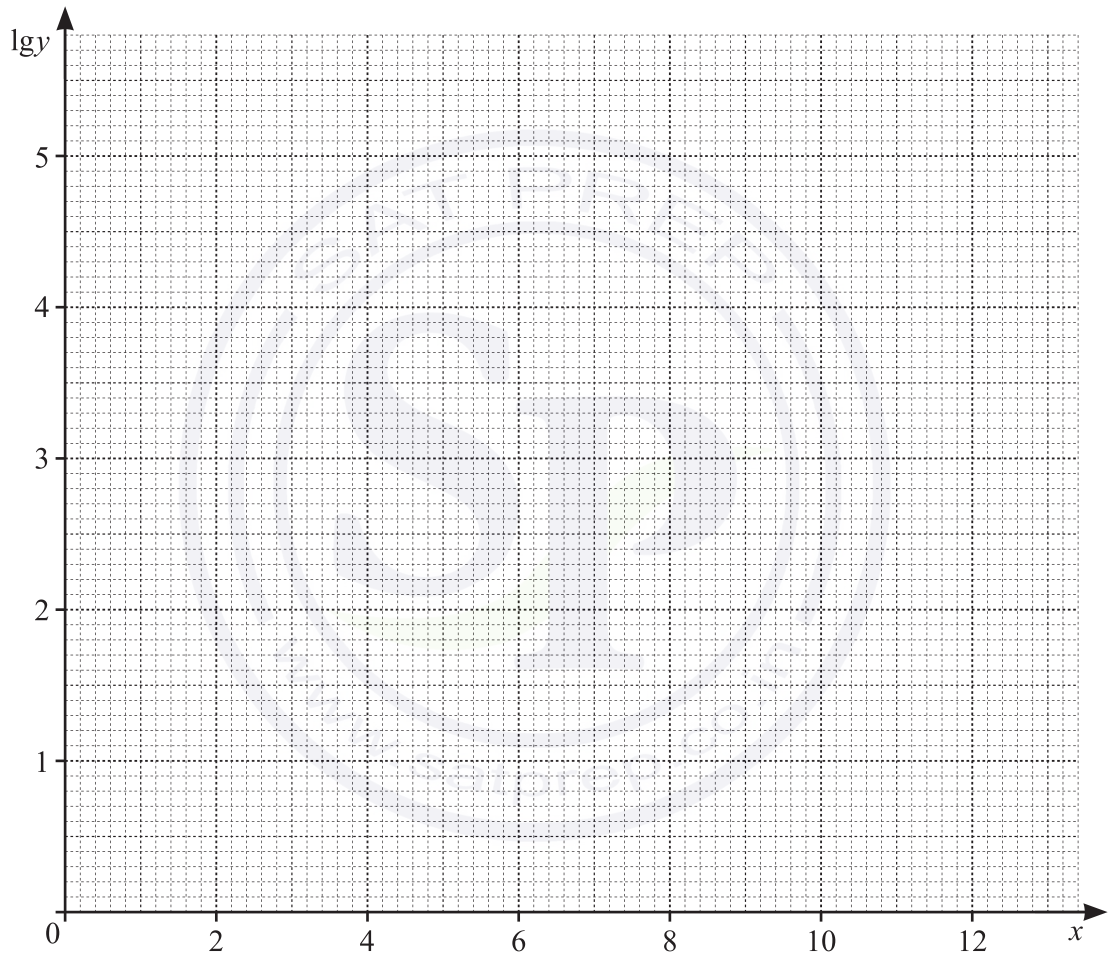
7 **(a)** The curves $4x^2 - 3y^2 + xy = 24$ and $y = \dfrac{2}{x}$ intersect at the points P and Q. Find the coordinates of P and Q. [5]

(b) Find the length of PQ. Give your answer in the form $a\sqrt{b}$, where a is rational and b is the smallest possible integer. [2]

8 Variables y and x are known to be connected by the relationship $y = Ab^x$ where A and b are constants. The table shows values of y for certain values of x.

x	1	3	5	10	12
y	38	150	600	20 500	82 000

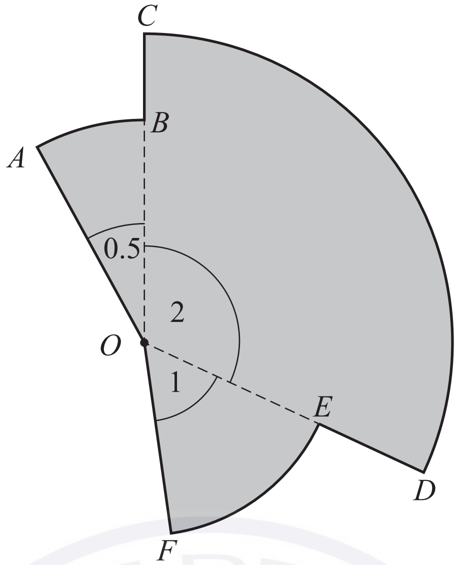
(a) Draw the graph of $\lg y$ against x. [2]



(b) Use your graph to find values of A and b, giving each to 1 significant figure. [6]

(c) Find an estimate of x when $y = 1500$. [2]

9 In this question all lengths are in centimetres and all angles are in radians.



The diagram shows a company logo. Each part of the logo is a sector of a circle with centre O.

Sector AOB has radius x.
Sector COD has radius $x+2$.
Sector EOF has radius y.
The shaded region has area $A\,\text{cm}^2$ and perimeter 24.

It is given that x and y can vary.

(a) Show that $A = \frac{91}{8}x^2 - 68x + 132$. [4]

(b) Use differentiation to find the minimum possible area of the logo. [5]

10 The expansion of $\left(a+\frac{x}{a}\right)^n$ in ascending powers of x begins b^4+48b^3x, where n, a and b are positive integers.

(a) Show that $a^{\frac{n}{2}-4}=\left(\frac{48}{n}\right)^2$. [4]

(b) Given also that the third term is $1056b^2x^2$, find the values of n, a and b. [6]

Question 11 is printed on the next page.

11 A cylinder, open at both ends, has base radius r cm and height $4r$ cm. Its curved surface area is S cm^2.

Given that r varies with time t, find S at the instant when $\frac{dS}{dt} = 6\frac{dr}{dt}$. [5]

Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

1799737130

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2023**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION
- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (CJ/JG) 317780/2

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 **(a)** Write $19 - 12x - 3x^2$ in the form $a(x+b)^2 + c$ where a, b and c are integers. [4]

(b) Hence find the maximum value of $19 - 12x - 3x^2$ and the value of x at which this maximum occurs. [2]

(c) Use your answer to **part (a)** to solve the equation $19 - 12\sqrt{u} - 3u = 0$. [3]

2 Solve the following simultaneous equations.

$$5x - 3\ln y = 2$$
$$x + \ln y = 1$$

[4]

3 **(a)** Find $\int\left(4x+5-\frac{1}{2x+3}\right)\mathrm{d}x$. [3]

(b) Hence find the exact value of $\int_1^3\left(4x+5-\frac{1}{2x+3}\right)\mathrm{d}x$, simplifying your answer. [3]

4 In this question a and b are integers.

Three terms in the expansion of $(2+ax)^5(1+bx)$ are $32+112x-240x^2$. Find the values of a and b. [7]

5 In this question p and q are constants.

The normal to the curve $y = \frac{p}{x^2} + 5x - 2$, at the point where $x = 1$, has equation $y = -x + q$.

Find the values of p and q. [6]

6 Find the value of the constant a for which the line $y = (2a+1)x - 10$ is a tangent to the curve $y = ax^2 - 5x + 2$. [6]

7 A particle moves in a straight line. At time t seconds after passing through a fixed point O, its velocity, $v\,\mathrm{ms}^{-1}$, is given by $v = 10\sin 2t - 6\cos 2t$.

(a) Find an expression for the acceleration of the particle. [2]

(b) Find the acceleration when $t = \frac{\pi}{4}$. [1]

(c) Find the first time at which the acceleration is zero. [3]

(d) Find the displacement of the particle between $t = \frac{\pi}{4}$ and $t = \frac{\pi}{2}$. [4]

8 DO NOT USE A CALCULATOR IN THIS QUESTION.

Solve the equation $(2-\sqrt{10})x^2+x+(2+\sqrt{10})=0$, giving your answers in the form $a+b\sqrt{10}$, where a and b are rational. [7]

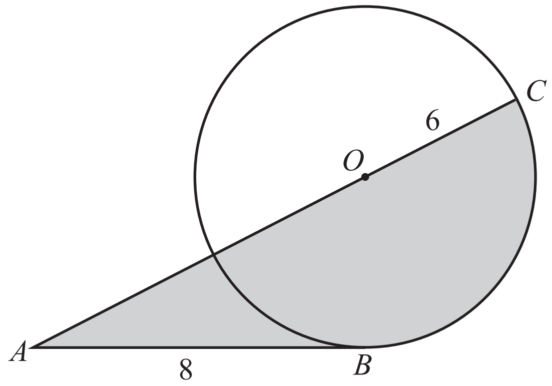
9 The functions f and g are defined as follows, for all real values of x.

$$f(x) = 2x^2 - 1$$
$$g(x) = e^x + 1$$

(a) Solve the equation $fg(x) = 8$. [3]

(b) For each of the functions f and g, either explain why the inverse function does not exist or find the inverse function, stating its domain. [4]

10 In this question all lengths are in centimetres.



The diagram shows a circle centre O with radius 6. The line AB is a tangent to the circle at the point B. The point C lies on the circle such that AOC is a straight line. $AB = 8$.

(a) Find the perimeter of the shaded region. [6]

(b) Find the area of the shaded region. [3]

11 **(a)** Show that $\dfrac{1}{\sec x - \operatorname{cosec} x} + \dfrac{1}{\sec x + \operatorname{cosec} x} = \dfrac{2\cos x}{1 - \cot^2 x}$. [5]

(b) Solve the equation $3\tan^2(y+\frac{\pi}{4}) = 1$ for $-2\pi < y < 0$. [4]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1677935236

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **October/November 2023**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
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INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (CE) 317885/1

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 **(a)** A straight line passes through the points (4, 23) and (−8, 29). Find the point of intersection, *P*, of this line with the line $y = 2x + 5$. [5]

(b) Find the distance of *P* from the origin. [2]

2 Find the non-zero value of k for which the line $y = -2x - 6k - 1$ is a tangent to the curve $y = x(x + 2k)$. [5]

3 DO NOT USE A CALCULATOR IN THIS QUESTION.

A cylinder has base radius $(2+\sqrt{3})$ m and volume $\pi(16+9\sqrt{3})\,\text{m}^3$. Find the exact value of its height, giving your answer in its simplest form. [4]

4 Solve the following equations.

(a) $\dfrac{(e^{x+1})^2}{\sqrt{e^x}} = 10$ [4]

(b) $2\log_9 y - \log_9(4y-9) = \dfrac{1}{2}$ [5]

5 **(a)** Find the equation of the normal to the curve $y = x^3 - 7x^2 + 12x - 5$ at the point (1, 1). [5]

(b) Find the x-coordinates of the two points where the normal cuts the curve again. Give your answers in the form $x = a \pm \sqrt{b}$ where a and b are integers. [5]

6 Find the exact value of $\int_2^3 \frac{(x+2)^2}{x}\,dx$. [6]

7 A particle is travelling in a straight line. Its displacement, s metres, from the origin at time t seconds is given by $s = 1.5e^{2t} + 2e^{-2t} - t$.

(a) Find expressions for the velocity, $v\,\text{ms}^{-1}$, and acceleration, $a\,\text{ms}^{-2}$, of the particle. [3]

(b) Find the time, T seconds, when the particle is at rest. [4]

(c) Find the acceleration of the particle at time T seconds. [2]

8 A curve has equation $y = x \sin 2x$.

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

(b) Find the equation of the tangent to the curve at $x = \frac{\pi}{4}$. [3]

(c) Use your answer to **part (a)** to find the exact value of $\int_0^{\frac{\pi}{6}} 2x\cos 2x\,dx$. [5]

9 **(a)** An arithmetic progression has twelve terms. The sum of the first three terms is -36 and the sum of the last three terms is 72. Find the first term and the common difference. [5]

(b) The first three terms of a geometric progression are 1, 1.2 and 1.44. Find the smallest value of n such that the sum of the first n terms is greater than 500. [5]

10 **(a)** By writing $\cot x$ and $\tan x$ in terms of $\cos x$ and $\sin x$, show that

$$\frac{\sin x}{1-\cot x}+\frac{\cos x}{1-\tan x}=\sin x+\cos x.$$ [5]

(b) Solve the equation $9\cot x + 3\operatorname{cosec} x = \tan x$, for $0° < x < 360°$. [5]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4065420722

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2023**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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INFORMATION

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- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (LK/FC) 317886/2

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
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$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

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

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

1 The functions f and g are defined as follows, for all real values of x.

$$f(x) = 2\sin x + 3\cos x$$

$$g(x) = e^{3x} - 1$$

(a) Find fg(0). [2]

(b) Find gg(x). [1]

(c) Solve the equation $g^{-1}(x) = \frac{1}{3}\ln 5$. [3]

2 Find the values of k for which the curve $y = x^2 + kx + (4k - 15)$ is completely above the x-axis. [4]

3 **(a)** Solve the following simultaneous equations.

$$3\log_2 x + 2\log_2 y = 24$$

$$5\log_2 x - 3\log_2 y = 2$$ [5]

(b) Solve the equation $\dfrac{2^{t+4}}{2^{1-2t}} = 512$. [4]

4 Find the exact value of $\int_3^5 \frac{(x-1)^2}{x^3}\,dx$. [6]

5 The curved surface area of a cylinder with radius r and height h is $2\pi rh$.

A closed cylinder has radius r cm and volume $1000\,\text{cm}^3$.

(a) Show that the total surface area of the cylinder is $2\pi r^2 + \dfrac{2000}{r}\,\text{cm}^2$. [3]

(b) Find the value of r which makes this area a minimum. You should show that your value of r gives a minimum for this area. [5]

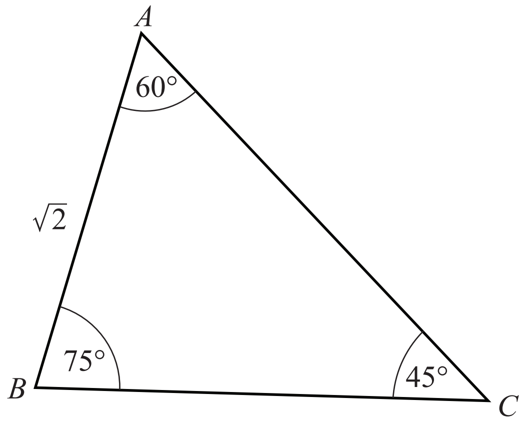
6 A particle travels in a straight line. Its displacement, s metres, from the origin, at time t seconds, where $t > 2$, is given by $s = \ln(4t^2 - 5) - t$.

(a) Find expressions for the velocity, $v\,\mathrm{ms}^{-1}$, and acceleration, $a\,\mathrm{ms}^{-2}$, of the particle. [4]

(b) Find the time when the particle is at rest. [3]

(c) Find the acceleration at this time. [2]

7 DO NOT USE A CALCULATOR IN THIS QUESTION.



You may use the following trigonometrical ratios.

$\sin 60° = \frac{\sqrt{3}}{2}$, $\sin 45° = \frac{\sqrt{2}}{2}$

$\cos 60° = \frac{1}{2}$, $\cos 45° = \frac{\sqrt{2}}{2}$

$\tan 60° = \sqrt{3}$, $\tan 45° = 1$

(a) Given that the area of triangle *ABC* is $\frac{3+\sqrt{3}}{4}$, show that $\sin 75° = \frac{\sqrt{6}+\sqrt{2}}{4}$. [5]

(b) Hence find the exact length of *AC*. [2]

8 **(a)** Show that $\frac{\sin x}{\tan x - 1} - \frac{\cos x}{\tan x + 1} = \frac{\cos x}{\sin^2 x - \cos^2 x}$. [5]

(b) Hence solve the equation $\dfrac{\sin x}{\tan x - 1} - \dfrac{\cos x}{\tan x + 1} = 1$ for $0° < x < 360°$. [5]

9 A curve has equation $y = xe^{2x}$.

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

(b) Find the equation of the normal to the curve at $x = 1$. [4]

(c) Use your answer to **part (a)** to find the exact value of $\int_0^2 2x\mathrm{e}^{2x}\,\mathrm{d}x$. [5]

10 **(a)** In an arithmetic progression the 5th term is 11. The 7th term is three times the 2nd term. Find the 1st term and the common difference. [4]

(b) A different arithmetic progression (AP) and a geometric progression (GP) have the following properties.

- The 1st terms of the AP and GP are both 3.
- The 2nd term of the AP is the same as the 3rd term of the GP.
- The 6th term of the AP is the same as the 5th term of the GP.
- The common ratio of the GP is greater than 1.

Find the common difference of the AP and the common ratio of the GP. [6]

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CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

2630070664

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2023**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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INFORMATION
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- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

DC (LK/CGW) 313043/3

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

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$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

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

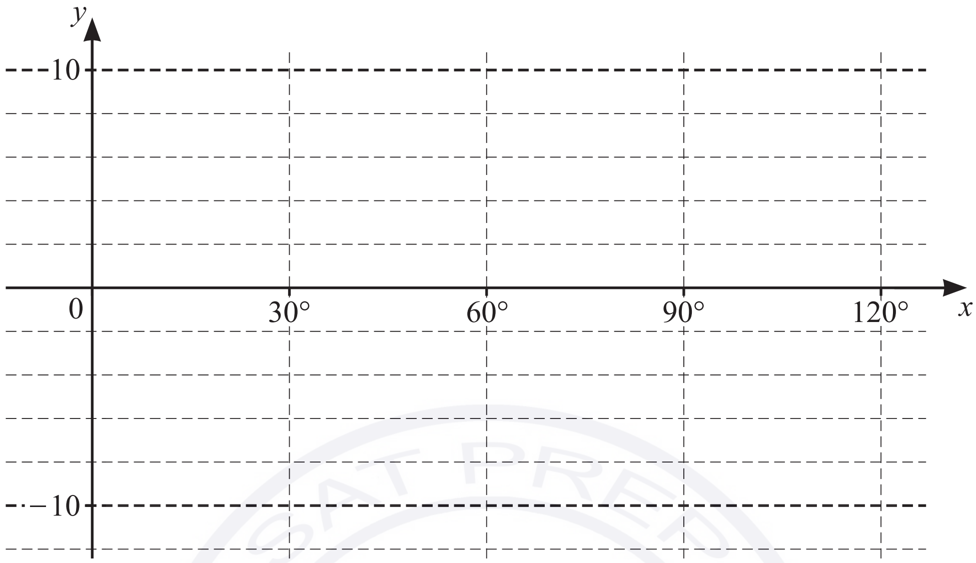
$$a^2 = b^2 + c^2 - 2bc\cos A$$

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

1 Variables x and y are such that when $\lg y$ is plotted against $\sqrt{x}$ a straight line passing through the points (1, 5) and (2.5, 8) is obtained. Show that $y = A \times b^{\sqrt{x}}$ where A and b are constants to be found. [4]

2 The function g is defined for $0° \leqslant x \leqslant 120°$ by $g(x) = 2 + 4\cos 6x$.

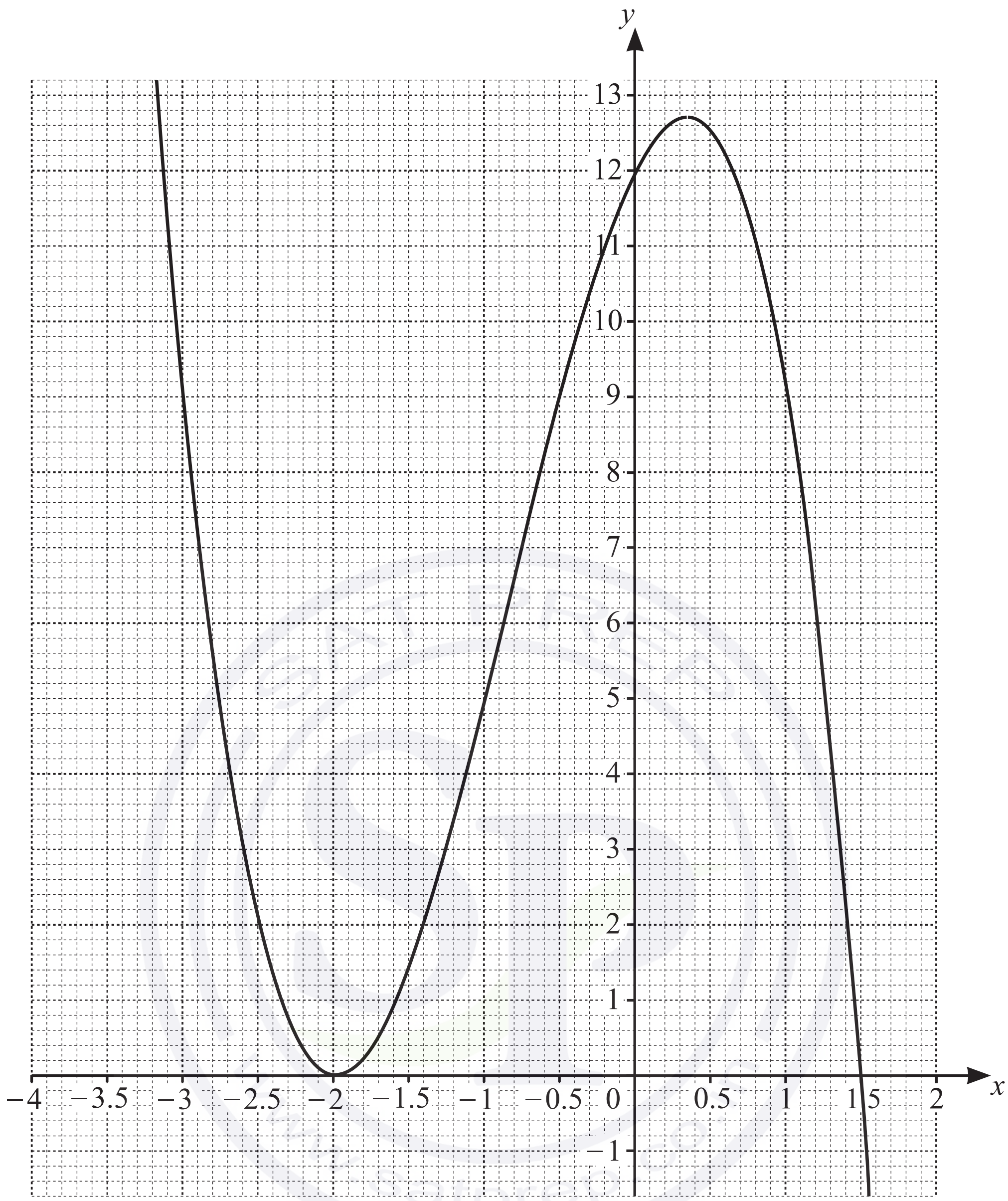
(a) On the axes, sketch the graph of $y = g(x)$. [3]



(b) State the amplitude of g. [1]

(c) State the period of g. [1]

3



The diagram shows the graph of $y = \mathrm{h}(x)$ where $\mathrm{h}(x) = (x + a)^2(b + cx)$ and a, b and c are integers. The curve meets the x-axis at the points $(-2, 0)$ and $(1.5, 0)$ and the y-axis at the point $(0, 12)$.

(a) Find the values of a, b and c. [2]

(b) Use the graph to solve the inequality $\mathrm{h}(x) \leqslant 9$. [3]

4 **(a)** Solve the equation $5^{2y-1} = 6 \times 3^{y}$, giving your answer correct to 3 decimal places. [3]

(b) Solve the equation $e^{2x} - 4 + 3e^{-2x} = 0$, giving your answers in exact form. [4]

5 The volume, V, of a sphere of radius r is given by $V = \frac{4}{3}\pi r^3$.

The volume of a sphere is increasing at a constant rate of $24\,\text{cm}^3\,\text{s}^{-1}$. Find the rate of increase of the radius when the radius is $6\,\text{cm}$. [4]

6 **(a)** The position vectors of the points P, Q and R relative to an origin O are $\begin{pmatrix}4\\7\end{pmatrix}$, $\begin{pmatrix}8\\5\end{pmatrix}$ and $\begin{pmatrix}x\\y\end{pmatrix}$ respectively. The point R lies on PQ extended such that $3\overrightarrow{QR} = 2\overrightarrow{PR}$. Use a vector method to find the values of x and y. [3]

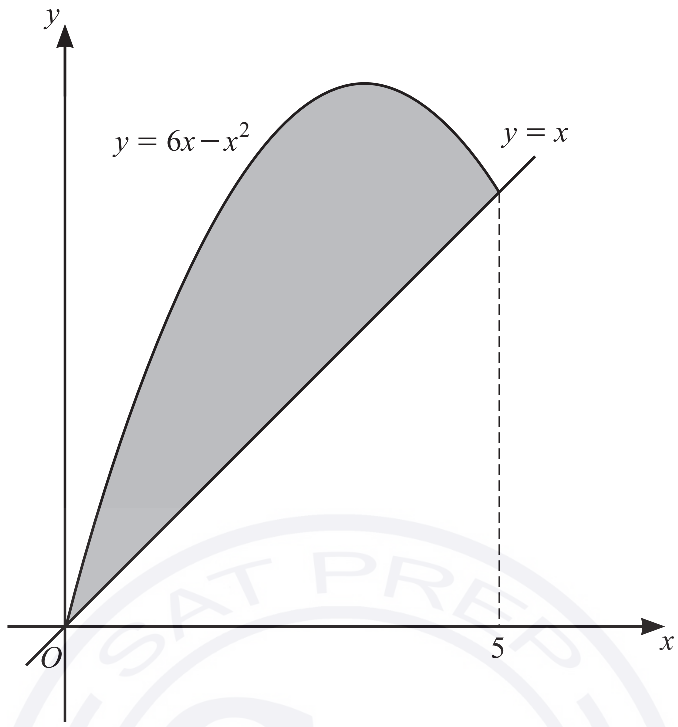
(b) You are given that **i** is a unit vector due east and **j** is a unit vector due north.

Three vectors, **a**, **b** and **c** are in the same horizontal plane as **i** and **j** and are such that $\mathbf{a} + \mathbf{b} = \mathbf{c}$.
The magnitude and bearing of **a** are 5 and 210°.
The magnitude and bearing of **c** are 10 and 330°.

(i) Find **a** and **c** in terms of **i** and **j**. [2]

(ii) Find the magnitude and bearing of **b**. [5]

7 (a)

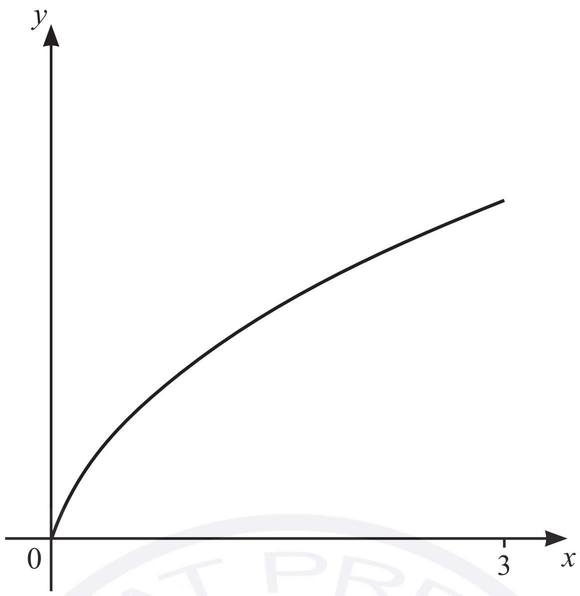


The diagram shows the curve $y = 6x - x^2$ for $0 \leqslant x \leqslant 5$ and the line $y = x$. Find the area of the shaded region. [4]

(b) **(i)** Find $\int\left(\frac{1}{(2x-6)^3}+\cos x\right)\mathrm{d}x$. [3]

(ii) Find $\int\frac{(x^4+1)^2}{2x}\,\mathrm{d}x$. [3]

8 **(a)**



The diagram shows the graph of $y = f(x)$ where f is defined by $f(x) = \dfrac{3x}{\sqrt{5x+1}}$ for $0 \leqslant x \leqslant 3$.

(i) Given that f is a one-one function, find the domain and range of f^{-1}. [3]

(ii) Solve the equation $f(x) = x$. [2]

(iii) On the diagram above, sketch the graph of $y = f^{-1}(x)$. [2]

(b) The functions g and h are defined by

$$g(x) = \sqrt[3]{8x^3 + 3} \quad \text{for} \quad x \geqslant 1,$$

$$h(x) = e^{4x} \quad \text{for} \quad x \geqslant k.$$

(i) Find an expression for $g^{-1}(x)$. [2]

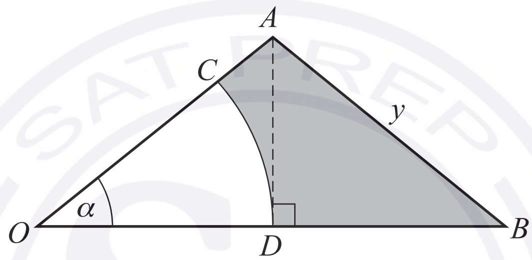
(ii) State the least value of the constant k such that $gh(x)$ can be formed. [1]

(iii) Find and simplify an expression for $gh(x)$. [1]

9 In this question all lengths are in centimetres and all angles are in radians.

(a) The area of a sector of a circle of radius 24 is $432\,\text{cm}^2$. Find the length of the arc of the sector. [4]

(b)



The diagram shows an isosceles triangle, OAB, with $AO = AB = y$ and height AD.
OCD is a sector of the circle with centre O. Angle AOB is α.

(i) Find an expression for OB in terms of y and α. [1]

(ii) Hence show that the area of the shaded region can be written as $\dfrac{y^2}{2}\cos\alpha(2\sin\alpha - \alpha\cos\alpha)$. [3]

10 In the expansion of $\left(ax+\frac{b}{x^2}\right)^9$, where a and b are constants with $a > 0$, the term independent of x is $-145\,152$ and the coefficient of x^6 is -6912. Show that $a^2b=-12$ and find the value of a and the value of b. [7]

Question 11 is printed on the next page.

11 The line with equation $x+3y=k$, where k is a positive constant, is a tangent to the curve with equation $x^2+y^2+2y-9=0$. Find the value of k and hence find the coordinates of the point where the line touches the curve. [9]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9458867497

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2023**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION
- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

DC (KN/CT) 313050/1

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 **(a)** Solve the inequality $3x^2 - 12x + 16 > 3x + 4$. [3]

(b) **(i)** Write $3x^2 - 12x + 16$ in the form $a(x+b)^2 + c$ where a, b and c are integers. [3]

(ii) Hence, write down the equation of the tangent to the curve $y = 3x^2 - 12x + 16$ at the minimum point of the curve. [1]

2 A curve has equation $y = 32x^2 + \dfrac{1}{8x^2}$ where $x \neq 0$.

(a) Find the coordinates of the stationary points of the curve. [5]

(b) These stationary points have the same nature. Use the second derivative test to determine whether they are maximum points or minimum points. [3]

3 DO NOT USE A CALCULATOR IN THIS QUESTION.

(a) Show that $x+3$ is a factor of $-12+23x+3x^2-2x^3$. [1]

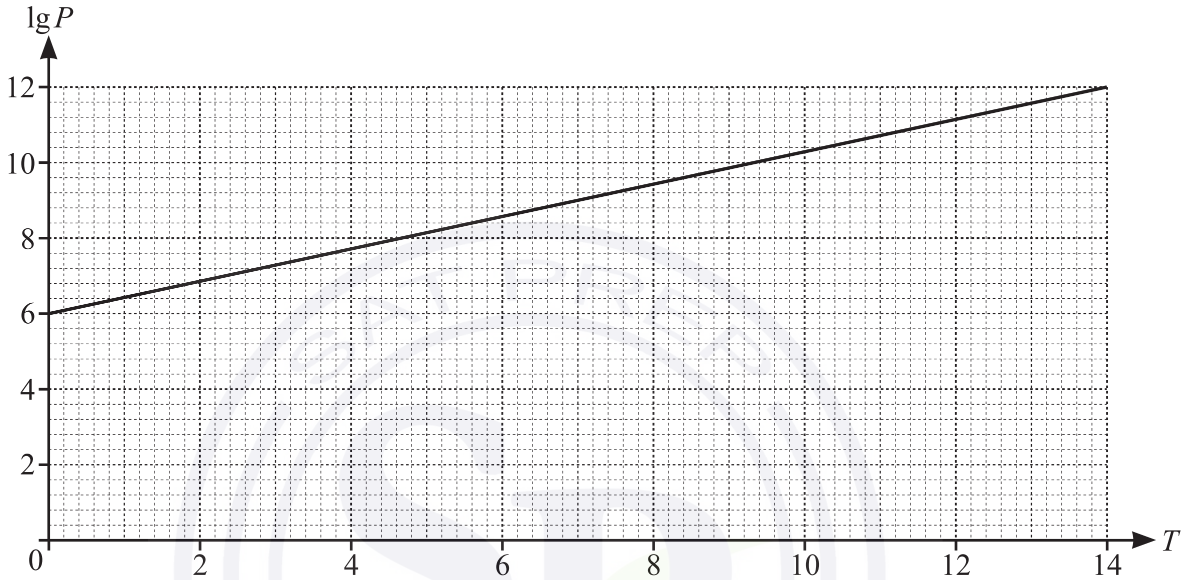
(b) The curve $y=-5+33x+3x^2-2x^3$ and the line $y=10x+7$ intersect at three points, A, B and C. These points are such that the x-coordinate of A has the least value and the x-coordinate of C has the greatest value. Show that B is the mid-point of AC. [7]

4 Variables x and y are related by the equation $y = 2 + \tan(1 - x)$ where $0 \leqslant x \leqslant \frac{\pi}{2}$. Given that x is increasing at a constant rate of 0.04 radians per second, find the corresponding rate of change of y when $y = 3$. [6]

5 Variables P and T are known to be connected by the relationship $P = Ab^T$, where A and b are constants. Values of P are found for certain values of time, T.

(a) Show that a graph of $\lg P$ against T will be a straight line. [2]

(b)



The diagram shows the graph of $\lg P$ against T. The graph passes through (0, 6) and (14, 12). Find the values of A and b. [4]

(c) Using the graph or otherwise, find the length of time for which P is between 100 million and 1000 million. [3]

6 **(a)** **(i)** Find the first three terms in the expansion of $\left(1+\frac{x}{7}\right)^5$, in ascending powers of x. Simplify the coefficient of each term. [2]

(ii) The expansion of $7(1+x)^n\left(1+\frac{x}{7}\right)^5$, where n is a positive integer, is written in ascending powers of x. The first two terms in the expansion are $7+89x$. Find the value of n. [2]

(b) In the expansion of $(k-2x)^8$, where k is a constant, the coefficient of x^4 divided by the coefficient of x^2 is $\frac{5}{8}$. The coefficient of x is positive. Form an equation and hence find the value of k. [5]

7 **(a)** $f(x) = \sqrt{3 + (4x - 2)^5}$ where $x > 1$.

Find an expression for $f'(x)$, giving your answer as a simplified algebraic fraction. [3]

(b) Variables x and y are related by the equation $y = \frac{5x}{3x+2}$. Using differentiation, find the approximate change in x when y increases from 10 by the small amount 0.01. [4]

(c) **(i)** Differentiate $y = x^3 \ln x$ with respect to x. [2]

(ii) Hence find $\int \left(\frac{x^2}{6}(2 + 3\ln x) \right) dx$. [3]

8 A curve has equation $y = \cos\dfrac{x}{4}$ where x is in radians. The normal to the curve at the point where $x = \dfrac{4\pi}{3}$ cuts the x-axis at the point P. Find the exact coordinates of P. [7]

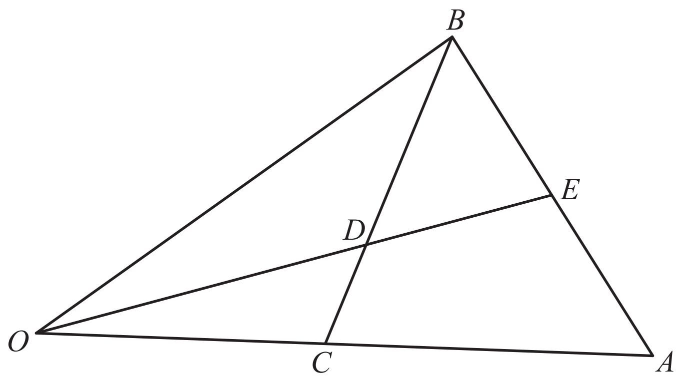
9 A particle travels in a straight line so that, t seconds after passing a fixed point, its velocity, $v\,\mathrm{ms}^{-1}$, is given by

$$v = e^{\frac{t}{4}} \qquad \text{for } 0 \leqslant t \leqslant 4,$$

$$v = \frac{16e}{t^2} \qquad \text{for } 4 \leqslant t \leqslant k.$$

The total distance travelled by the particle between $t = 0$ and $t = k$ is 13.4 metres. Find the value of k. [6]

10



The diagram shows a triangle OAB. The point C is the mid-point of OA. The point D lies on CB such that $CD : DB = 2 : 3$.

$$\overrightarrow{OC} = \mathbf{c} \qquad \overrightarrow{CB} = \mathbf{b}$$

The point E lies on AB such that $\overrightarrow{OE} = \lambda\overrightarrow{OD}$ and $\overrightarrow{AE} = \mu\overrightarrow{AB}$ where λ and μ are scalars.
Find two expressions for $\overrightarrow{OE}$, each in terms of $\mathbf{b}$, $\mathbf{c}$ and a scalar, and hence find $AE : EB$. [8]

Continuation of working space for Question 10.

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CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

1856076465

ADDITIONAL MATHEMATICS 0606/23

Paper 2

May/June 2023

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
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- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (PQ/CT) 313052/2

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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

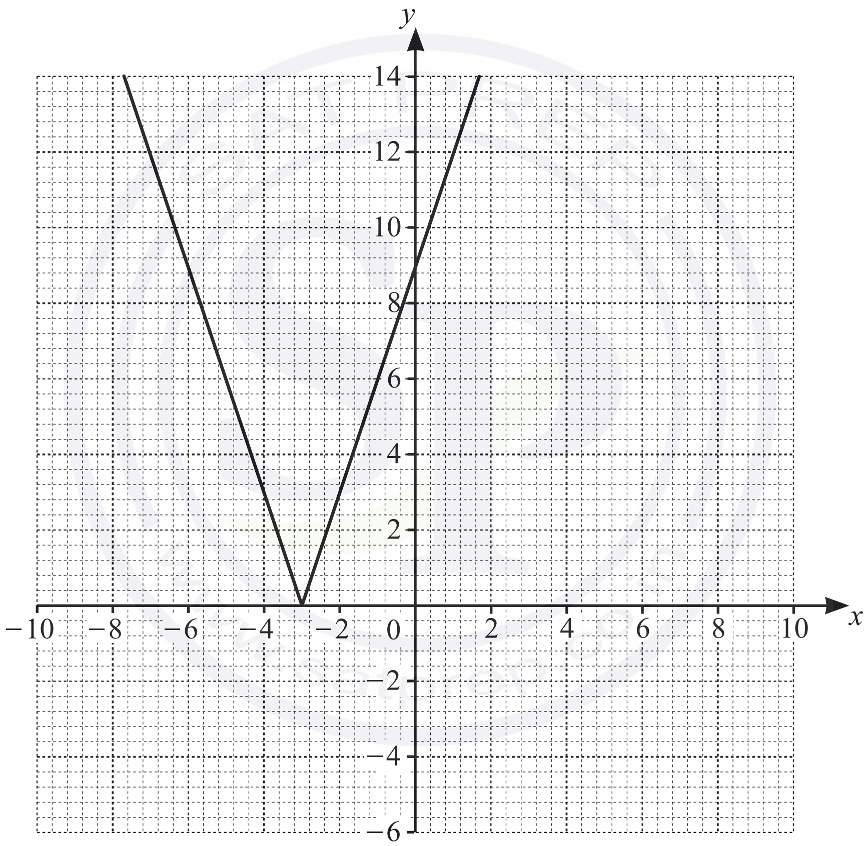
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

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

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

1 **(a)** Solve the equation $\dfrac{|4x-5|}{7}=1.$ [2]

(b)



The diagram shows the graph of $y=|3x+9|$.

By drawing a suitable graph on the same diagram, solve the inequality $|3x+9|\leqslant|x-5|$. [3]

2 DO NOT USE A CALCULATOR IN THIS QUESTION.

Write the expression $\dfrac{\sqrt{98x^{12}}}{3+\sqrt{2}}$ in the form $\left(a\sqrt{b}+c\right)x^{d}$ where a, b, c and d are integers. [4]

3 (a) Differentiate $\ln(x^3+3x^2)$ with respect to x, simplifying your answer. [2]

(b) Hence find $\displaystyle\int \frac{x+2}{x(x+3)}\mathrm{d}x$. [2]

4 The polynomial p is such that $p(x) = 2x^3 + 11x^2 + 22x + 40$.

(a) Show that $x = -4$ is a root of the equation $p(x) = 0$. [1]

(b) Factorise $p(x)$ and hence show that $p(x) = 0$ has no other real roots. [4]

5 **(a)** **(i)** A gardening group has 20 members. A committee of 6 members is to be selected. Anwar and Bo belong to the gardening group and at most one of them can be on the committee. How many different committees are possible? [2]

(ii) The gate for the garden has a lock with a 6-character passcode. The passcode is to be made from

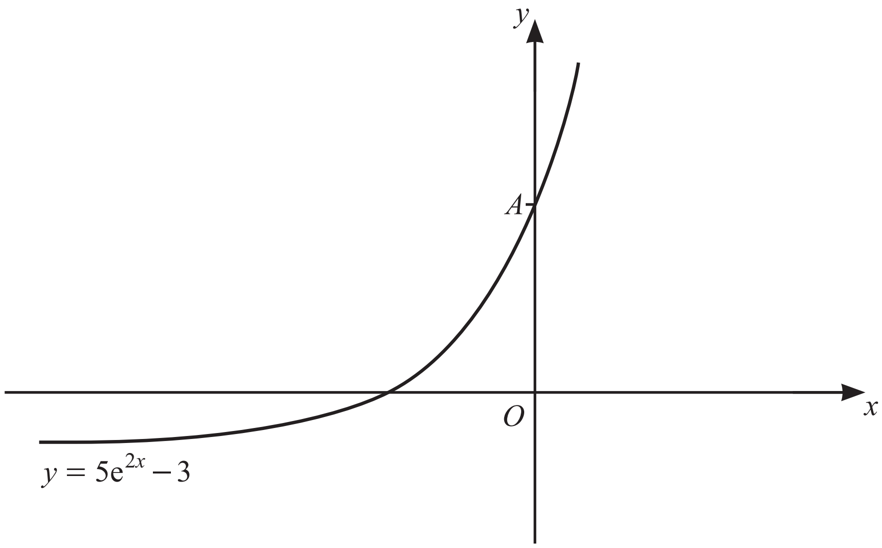
Letters	G	A	R	D	E	N				
Numbers	0	1	2	3	4	5	6	7	8	9.

No character may be used more than once in any passcode.
Find the number of possible passcodes that have 4 letters followed by 2 numbers. [2]

(b) **(i)** Given that $n \geqslant 4$, show that $(n-3) \times {}^nC_3 = 4 \times {}^nC_4$. [2]

(ii) Given that ${}^nC_3 = 5n$, where $n \geqslant 3$, show that n satisfies the equation $n^2 - 3n - 28 = 0$. Hence find the value of n. [4]

6



The diagram shows the curve $y = 5e^{2x} - 3$. The curve meets the y-axis at the point A. The tangent to the curve at A meets the x-axis at the point B. Find the length of AB. [6]

7 Variables x and y are such that $y = \dfrac{4x^3 + 2\sin 8x}{1-x}$. Use differentiation to find the approximate change in y as x increases from 0.1 to $0.1 + h$, where h is small. [6]

8 **(a)** The functions f and g are defined by

$$f(x) = \sec x \qquad \text{for } \frac{\pi}{2} < x < \frac{3\pi}{2}$$

$$g(x) = 3(x^2 - 1) \qquad \text{for all real } x.$$

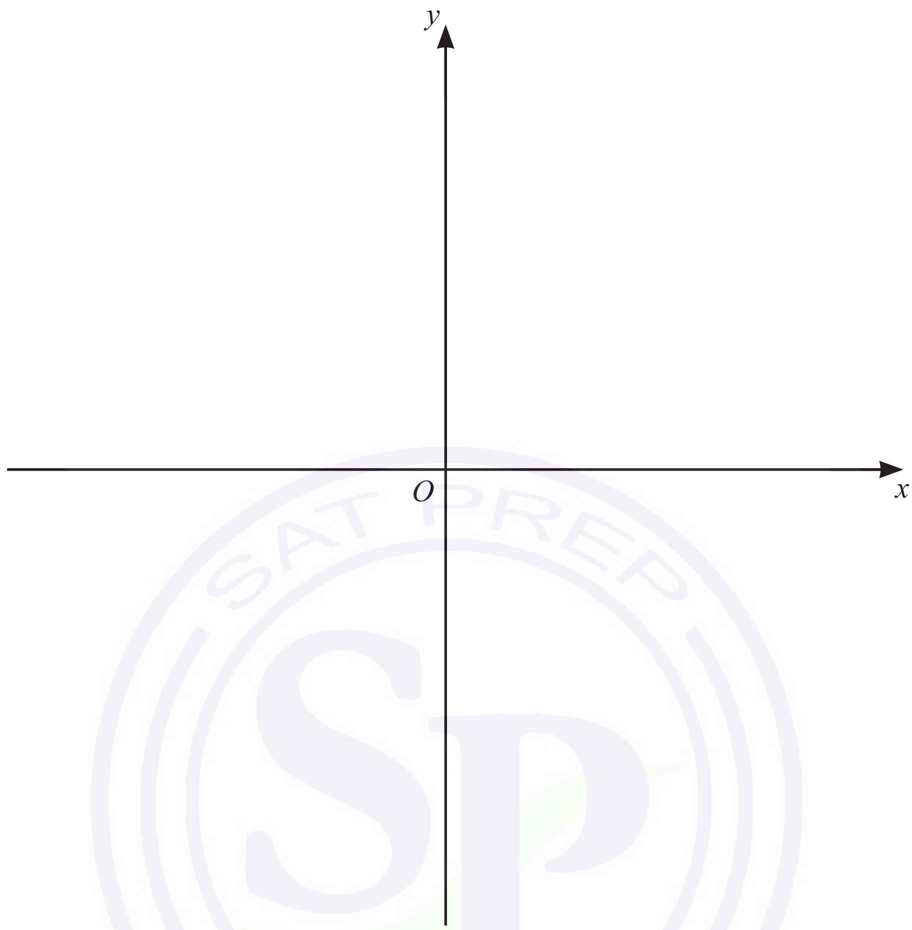
(i) Find the range of f. [1]

(ii) Solve the equation $f^{-1}(x) = \frac{2\pi}{3}$. [3]

(iii) Given that gf exists, state the domain of gf. [1]

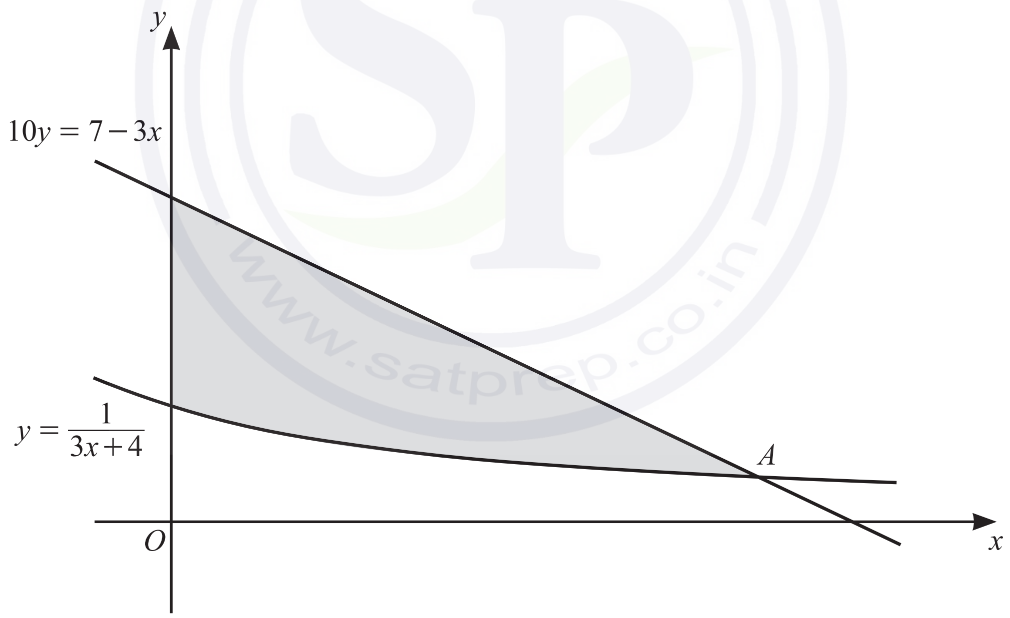
(iv) Solve the equation $gf(x) = 1$. [5]

(b) The function h is defined by $h(x) = \ln(4-x)$ for $x < 4$. Sketch the graph of $y = h(x)$ and hence sketch the graph of $y = h^{-1}(x)$. Show the position of any asymptotes and any points of intersection with the coordinate axes. [4]



9 **(a)** Show that $\int_1^8 \frac{x+4}{\sqrt[3]{x}}\,dx = 36.6$. [3]

(b)



The diagram shows part of the line $10y = 7 - 3x$ and part of the curve $y = \frac{1}{3x+4}$.
The line and curve intersect at the point A. Verify that the y-coordinate of A is 0.1 and calculate the area of the shaded region. [8]

Continuation of working space for Question 9(b).

10 An arithmetic progression, A, has first term a and common difference d.
The 2nd, 14th and 17th terms of A form the first three terms of a convergent geometric progression, G, with common ratio r.

(a) **(i)** Given that $d \neq 0$, find two expressions for r in terms of a and d and hence show that $a = -17d$. [6]

(ii) Find the value of r. [2]

(b) The first term of the geometric progression, G, is q and the sum to infinity is $\frac{256}{3}$.

Find the sum of the first 20 terms of the **arithmetic** progression, A. [7]

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Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4810484657

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **February/March 2023**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
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- Do **not** write on any bar codes.
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- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

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This document has **16** pages.

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
$$\sec^2 A = 1 + \tan^2 A$$
$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

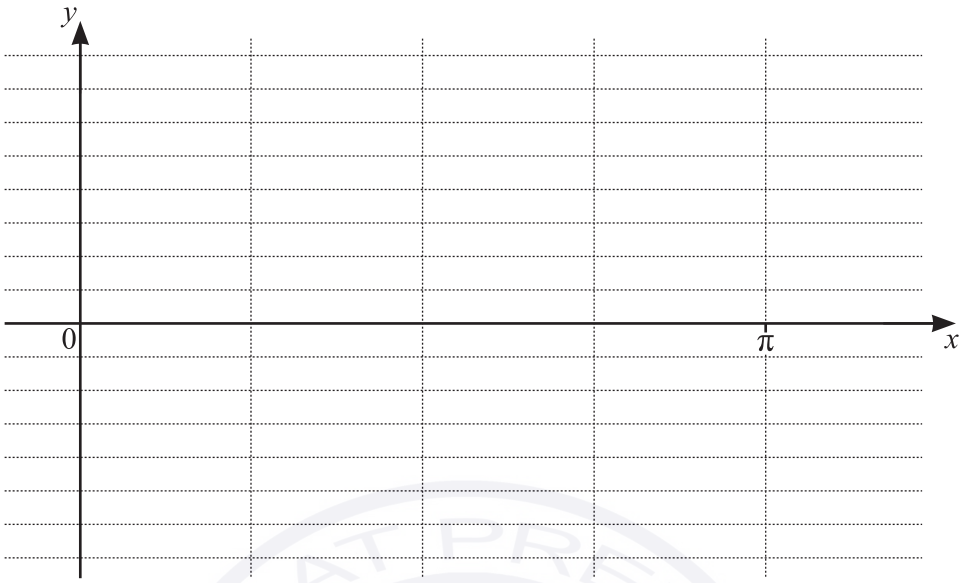
Formulae for ΔABC

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

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

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

1 On the axes below, sketch the graph of $y = |4\cos 2x|$ for $0 \leqslant x \leqslant \pi$, giving the coordinates of any points where the graph meets the axes. [3]



2 **DO NOT USE A CALCULATOR IN THIS QUESTION.**

Expand and simplify $\left(\dfrac{x\sqrt{11}}{2\sqrt{3}-1}\right)^2$, giving your answer with a rational denominator. [4]

3 Solve the inequality $|5x+4| \leqslant |2x-3|$. [4]

4 $$y = \frac{\sec^2 5x - \tan^2 5x}{\operatorname{cosec} 5x}$$

Show that $y = a\sin bx$, where a and b are integers, and hence find the value of $\int_0^{\frac{\pi}{5}} y\,\mathrm{d}x$. [4]

5 **DO NOT USE A CALCULATOR IN THIS QUESTION.**

(a) Show that $x-1$ is a factor of the expression $x^3-2x^2-19x+20$. [1]

(b) Hence write $x^3-2x^2-19x+20$ as a product of its linear factors. [3]

(c) Hence find the exact solutions of the equation $e^{3y}-2e^{2y}-19e^{y}+20=0$. [2]

6 **(a)** A geometric progression has first term 64 and common ratio 0.5.

(i) Find the 10th term. [2]

(ii) Find the sum of the first 10 terms. [2]

(iii) Find the sum to infinity. [1]

(b) An arithmetic progression is such that $S_{20} - 400 = 2S_{10}$ and $u_1 : u_6$ is 1 : 5.
Find the sum of the first 3 terms of this progression. [6]

7 **(a)** Variables x and y are such that $y = \dfrac{1+\cos^2 x}{\tan x}$. Use differentiation to find the approximate change in y as x increases from $\dfrac{\pi}{4}$ to $\dfrac{\pi}{4}+h$, where h is small. [5]

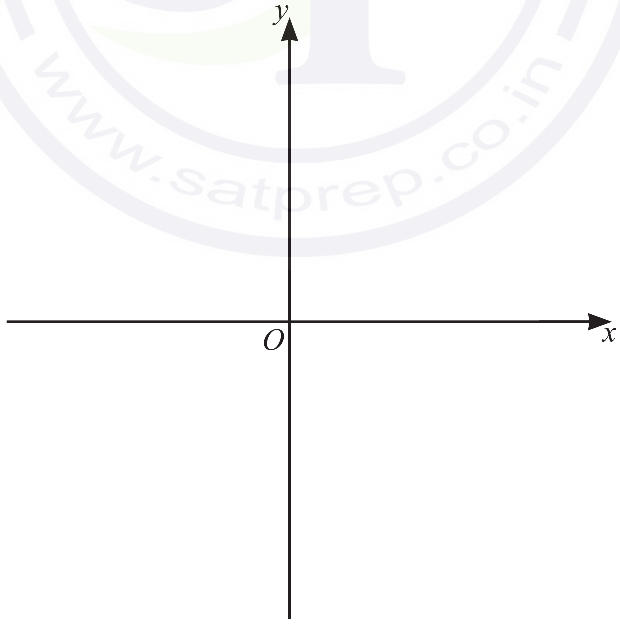
(b) Given that $y = \frac{1}{(x-3)^3}$ show that $y - \frac{dy}{dx} - \frac{1}{3}\left(\frac{d^2y}{dx^2}\right)$ can be written as $\frac{(x+1)(x-4)}{(x-3)^5}$. [4]

8 The function f is defined for $x \geqslant 0$ by $f(x) = 5 - 2e^{-x}$.

(a) **(i)** Find the domain of f^{-1}. [2]

(ii) Solve $ff^{-1}(x) = \sqrt{5x-4}$. [3]

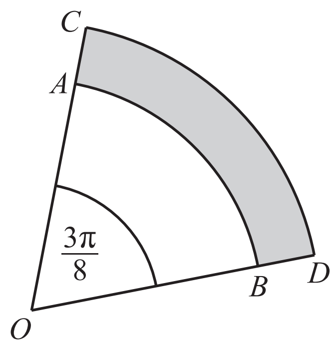
(iii) On the axes, sketch the graph of $y = f(x)$ and hence sketch the graph of $y = f^{-1}(x)$. Show clearly the positions of any points where your graphs meet the coordinate axes and the positions of any asymptotes. [4]



(b) The function g is defined for $0 \leqslant x \leqslant 0.2$ by $g(x) = \dfrac{3}{1-x}$.
Find and simplify an expression for $f^{-1}g(x)$. [4]

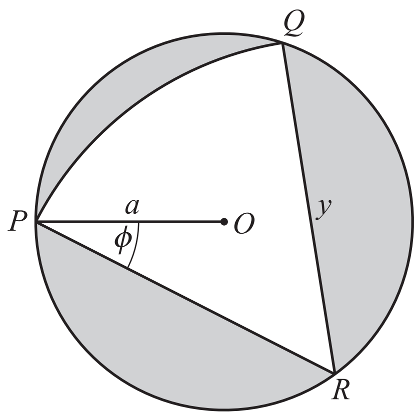
9 In this question, all lengths are in centimetres and all angles are in radians.

(a)



The diagram shows sectors *AOB* and *COD* of two circles with the same centre, *O*. Angle *AOB* is $\frac{3\pi}{8}$ and the length of *OC* is 6.5. It is given that *OAC* and *OBD* are straight lines and *OA* : *OC* is 4 : 5. Find the perimeter of the shaded region. [3]

(b)



The diagram shows a circle with centre O and radius a. Sector PQR is a sector of a different circle with centre R and radius y. Angle OPR is ϕ. Find, in terms of a and ϕ only, the total area of the three shaded regions. Simplify your answer. [4]

10 A particle P moves in a straight line such that, t seconds after passing a fixed point O, its acceleration, $a\,\text{ms}^{-2}$, is given by

$$a = 6t \qquad \text{for } 0 \leqslant t \leqslant 3,$$
$$a = \frac{18e^3}{e^t} \qquad \text{for } t \geqslant 3.$$

When $t = 1$, the velocity of P is $2\,\text{ms}^{-1}$ and its displacement from O is -4 m.

(a) **(i)** Find the velocity of P when $t = 3$. [3]

(ii) Find the displacement of P from O when $t = 3$. [3]

(b) Find an expression in terms of t for the displacement of P from O when $t \geqslant 3$. [4]

Question 11 is printed on the next page.

11 The normal to the curve $y = \sin(4x - \pi)$ at the point $A(a, 0)$, where $\frac{\pi}{2} < a < \pi$, meets the y-axis at the point B. Find the exact area of triangle OAB, where O is the origin. [9]

Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3385575014

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2022**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
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INFORMATION
- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (LK) 302846/3

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 $\binom{n}{r} = \frac{n!}{(n-r)!\,r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
$$\sec^2 A = 1 + \tan^2 A$$
$$\text{cosec}^2 A = 1 + \cot^2 A$$

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 Solve the following simultaneous equations, giving your answers in the form $a+b\sqrt{7}$ where a and b are integers.

$$x+3y=11$$

$$x-\sqrt{7}y=7$$

[5]

2 DO NOT USE A CALCULATOR IN THIS QUESTION.

Find the x-coordinates of the points where the line $y = 3x - 8$ cuts the curve $y = 2x^3 + 3x^2 - 26x + 22$. [5]

3 **(a)** Find the coordinates of the point on the curve $y = \sqrt{1+3x}$ where the gradient of the normal is $-\frac{8}{3}$. [5]

(b) Find the equation of the normal to the curve $y = \sqrt{1+3x}$ at the point (8, 5) in the form $y = mx + c$. [3]

4 Solve the following equations, giving your answers to 3 significant figures.

(a) $2^{3x+1} = 5^{x-2}$ [3]

(b) $e^{2y+1} = 1 + \frac{6}{e^{2y+1}}$ [4]

5 You are given that $y = \dfrac{1}{\cos 2x}$.

(a) Show that $\dfrac{dy}{dx} = \dfrac{k \sin 2x}{\cos^2 2x}$ where k is a constant to be found. [2]

(b) Find the values of x such that $\dfrac{dy}{dx} = \dfrac{5}{\sin 2x}$ for $0 < x < \dfrac{\pi}{2}$. [4]

6 **(a)** Write $3x^2 + 15x - 20$ in the form $a(x+b)^2 + c$ where a, b and c are rational numbers. [4]

(b) State the minimum value of $3x^2 + 15x - 20$ and the value of x at which it occurs. [2]

(c) Use your answer to **part (a)** to solve the equation $3y^{\frac{2}{3}} + 15y^{\frac{1}{3}} - 20 = 0$, giving your answers correct to three significant figures. [3]

7 The sum of the first three terms of a geometric progression is 17.5 and the sum to infinity is 20. Find the first term and the common ratio. [6]

8 The equation of a curve is $y = x\sin x$.

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

(b) Find the equation of the tangent to the curve at $x = \dfrac{\pi}{2}$ in the form $y = mx + c$. [3]

(c) Use your answer to **part (a)** to find $\int x\cos x\,\mathrm{d}x$. [3]

(d) Evaluate $\int_0^{\frac{\pi}{4}} x\cos x\,\mathrm{d}x$, giving your answer correct to 2 significant figures. [2]

9 The functions $f(x)$ and $g(x)$ are defined as follows for $x > -\frac{1}{3}$ by

$$f(x) = x^2 + 1,$$
$$g(x) = \ln(3x + 2).$$

(a) Find $fg(x)$. [1]

(b) Solve the equation $fg(x) = 5$ giving your answer in exact form. [3]

(c) Solve the equation $gg(x) = 1$. [6]

10 The acceleration, $a\,\text{ms}^{-2}$, of a particle at time t seconds is given by $a = -\frac{45}{(t+1)^2}$. When $t = 0$ the velocity of the particle is $50\,\text{ms}^{-1}$.

(a) Find an expression for the velocity of the particle in terms of t. [4]

(b) Find the distance travelled by the particle between $t = 1$ and $t = 10$. [4]

11 A 5-digit code is to be formed using 5 different numbers selected from 1, 2, 3, 4, 5, 6, 7, 8. Find how many possible codes there are if the code forms

(a) a number less than 60 000 that ends in a multiple of 3, [3]

(b) an even number less than 60 000. [3]

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Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1130745556

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **October/November 2022**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (KN/CT) 303196/2

[Turn over

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 Solve the following simultaneous equations.

$$x+5y=-4$$
$$3y-xy=6$$

[5]

2 Solve the equation $4e^{2x-3}=7e^{5-x}$. [4]

3 In this question a and b are constants.

The normal to the curve $y = \frac{a}{x} + 3x - 2$ at the point where $x = 1$ has equation $y = -\frac{1}{4}x + b$. Find the values of a and b. [6]

4 Solve the equation $\log_3(11x-8) = 1 + \dfrac{2}{\log_x 3}$ given that $x > 1$. [5]

5 DO NOT USE A CALCULATOR IN THIS QUESTION.

Find the x-coordinates of the points of intersection of the curves $y = 7x^3 - 7x^2 - 17x - 4$ and $y = x^3 - 2x^2 - 4x - 16$. [5]

6 A 4-digit code is to be formed using 4 different numbers selected from 2, 3, 4, 5, 6, 7, 8 and 9. Find how many possible codes there are if the code forms

(a) a number that is odd and greater than 5000, [3]

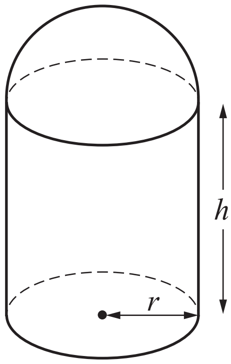
(b) a number greater than 5000 with a last digit that is prime. [3]

7 **(a)** Show that $\dfrac{\sin x}{1-\cos x}+\dfrac{1-\cos x}{\sin x}=2\operatorname{cosec} x$. [4]

(b) Hence solve the equation $\dfrac{\sin x}{1-\cos x}+\dfrac{1-\cos x}{\sin x}=3\sin x-1$ for $0° < x < 360°$. [4]

8 In this question all lengths are in centimetres.

The volume of a cylinder with radius r and height h is $\pi r^2 h$ and its curved surface area is $2\pi rh$.
The volume of a sphere with radius r is $\frac{4}{3}\pi r^3$ and its surface area is $4\pi r^2$.



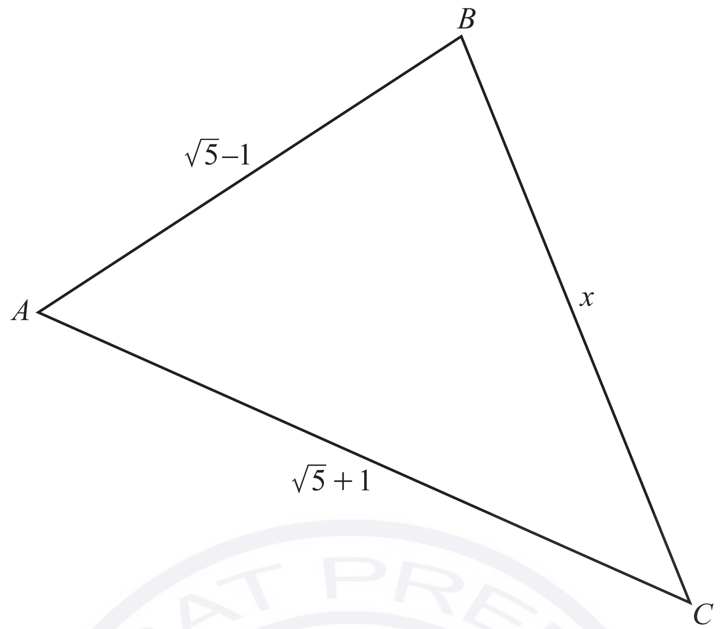
The diagram shows a solid object in the shape of a cylinder of base radius r and height h, with a hemisphere of radius r on top. The total surface area of the object is $300\,\text{cm}^2$.

(a) Find an expression for h in terms of r. [2]

(b) Show that the volume, V, of the object is $150r - \frac{5}{6}\pi r^3$. [3]

(c) Find the maximum volume of the object as r varies. [5]

9 In this question all lengths are in centimetres.



The diagram shows triangle ABC which has area $\dfrac{2\sqrt{5}}{3}\text{cm}^2$. Angle A is acute.

(a) Find the exact value of $\sin A$. [3]

(b) Find the exact value of $\cos A$ and hence find the exact value of x. [5]

(c) Find the exact value of $\sin B$. [3]

10 **(a)** A geometric progression has third term 4.5 and sixth term 15.1875. Find the first term and the common ratio. [4]

(b) Find the sum of ten terms of the progression, starting with the sixteenth term. Give your answer to the nearest integer. [4]

11 The coordinates of points A and B are $(-5, 6)$ and $(4, -6)$ respectively. The point C lies on the line AB, between A and B, such that $\frac{AC}{CB} = \frac{1}{2}$.

(a) Find the coordinates of C. [2]

(b) The line CD is perpendicular to AB. Find the equation of CD in the form $y = mx + c$. [4]

(c) The length of BD is $\sqrt{125}$. Find the coordinates of the two possible positions of point D. [6]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8638626774

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2022**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
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- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (RW/JG) 303216/2

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 Solve the following inequality.

$$(2x+3)(x-4) > (3x+4)(x-1)$$ [5]

2 The tangent to the curve $y = ax^2 - 5x + 2$ at the point where $x = 2$ has equation $y = 7x + b$. Find the values of the constants a and b. [5]

3 Solve the equation $\lg(2x-1) + \lg(x+2) = 2 - \lg 4$. [5]

4 The line $y = kx + 6$ intersects the curve $y = x^3 - 4x^2 + 3kx + 2$ at the point where $x = 2$.

(a) Find the value of k. [2]

(b) Show that, for this value of k, the line cuts the curve only once. [4]

5 **(a)** Show that $\dfrac{\cos x}{1-\sin x}+\dfrac{1-\sin x}{\cos x}=2\sec x$. [4]

(b) Hence solve the equation $\dfrac{\cos\dfrac{\theta}{2}}{1-\sin\dfrac{\theta}{2}}+\dfrac{1-\sin\dfrac{\theta}{2}}{\cos\dfrac{\theta}{2}}=8\cos^2\dfrac{\theta}{2}$ for $-360° < \theta < 360°$. [4]

6 The first four terms in ascending powers of x in the expansion $(3+ax)^4$ can be written as $81+bx+cx^2+\frac{3}{2}x^3$. Find the values of the constants a, b and c. [6]

7 Given that ${}^nC_4 = 13\times{}^nC_2$, find the value of ${}^nC_8$. [5]

8 **(a)** Particle A starts from the point with position vector $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$ and travels with speed $26\,\text{ms}^{-1}$ in the direction of the vector $\begin{pmatrix} 12 \\ 5 \end{pmatrix}$. Find the position vector of A after t seconds. [3]

(b) At the same time, particle B starts from the point with position vector $\begin{pmatrix} 67 \\ -18 \end{pmatrix}$. It travels with speed $20\,\text{ms}^{-1}$ at an angle of α above the positive x-axis, where $\tan\alpha = \frac{3}{4}$. Find the position vector of B after t seconds. [4]

(c) Hence find the time at which A and B meet, and the position where this occurs. [3]

9 The equation of a curve is $y = kxe^{-2x}$, where k is a constant.

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

(b) Find the coordinates of the stationary point on the curve $y = 10xe^{-2x}$. [3]

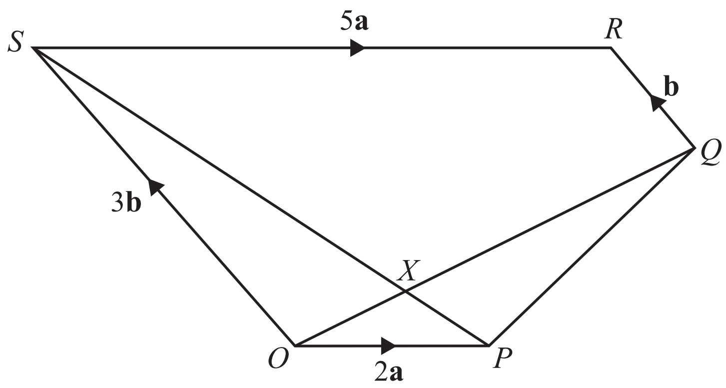
(c) Use your answer to **part (a)** to find $\int 4x\mathrm{e}^{-2x}\,\mathrm{d}x$. [3]

(d) Find the exact value of $\int_0^1 4x\mathrm{e}^{-2x}\,\mathrm{d}x$. [2]

10 **(a)** The third term of an arithmetic progression is 10 and the sum of the first 8 terms is 116. Find the first term and common difference. [5]

(b) Find the sum of nineteen terms of the progression, starting with the twelfth term. [4]

11



In the vector diagram, $\overrightarrow{OP} = 2\mathbf{a}$, $\overrightarrow{SR} = 5\mathbf{a}$, $\overrightarrow{OS} = 3\mathbf{b}$ and $\overrightarrow{QR} = \mathbf{b}$.

(a) Given that $\overrightarrow{PX} = \lambda\overrightarrow{PS}$, write $\overrightarrow{OX}$ in terms of **a**, **b** and λ. [3]

(b) Given that $\overrightarrow{OX} = \mu\overrightarrow{OQ}$, write $\overrightarrow{OX}$ in terms of **a**, **b** and μ. [2]

(c) Find the values of λ and μ. [4]

(d) Write down the value of $\frac{OX}{OQ}$. [1]

(e) Find the value of $\frac{PX}{XS}$. [1]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8556606969

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2022**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages.

DC (NF/CGW) 214154/2

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 $\binom{n}{r} = \frac{n!}{(n-r)!\,r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
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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 **(a)** Solve the equation $5^{w-1} = 12$, giving your answer correct to 2 decimal places. [2]

(b) Solve the equation $x^{\frac{2}{3}} - 5x^{\frac{1}{3}} + 6 = 0$. [3]

2 **(a)** Write $2\lg x - (\lg(x+6) + \lg 3)$ as a single logarithm to base 10. [2]

(b) Hence solve the equation $2\lg x - (\lg(x+6) + \lg 3) = 0$. [4]

3 Variables x and y are such that when $\sqrt[3]{y}$ is plotted against x^2, a straight line passing through the points (9, 8) and (16, 1) is obtained. Find y as a function of x. [4]

4 The polynomial $p(x) = mx^3 - 17x^2 + nx + 6$ has a factor $x - 3$. It has a remainder of -12 when divided by $x + 1$. Find the remainder when $p(x)$ is divided by $x - 2$. [6]

5 **(a)** **(i)** Write down, in ascending powers of x, the first three terms in the expansion of $(1+4x)^n$. Simplify each term. [2]

(ii) In the expansion of $(1+4x)^n(1-4x)$ the coefficient of x^2 is 6032. Given that $n > 0$, find the value of n. [3]

(b) Find the term independent of x in the expansion of $\left(\frac{x}{2}-\frac{8}{x^4}\right)^{10}$. [2]

6 **(a)** **(i)** A 5-digit number is to be formed from the seven digits 0, 1, 2, 3, 4, 5, 6. Each digit can be used at most once in any number and the number does not start with 0. Find the number of ways in which this can be done. [2]

(ii) Find how many of these 5-digit numbers are even. [3]

(b) A team of 7 people is to be selected from a group of 9 women and 6 men. Find the number of different teams that can be selected which include at least one man. [2]

(c) **(i)** Show that $^{n}C_3 + {}^{n}C_2 = \frac{1}{6}(n^3 - n)$ for $n \geqslant 3$. [5]

(ii) Hence solve the equation $^{n}C_3 + {}^{n}C_2 = 4n$ where $n \geqslant 3$. [2]

7 Variables x and y are such that $y = \dfrac{(1 + \sin 3x)^4}{\sqrt{x}}$. Use differentiation to find the approximate change in y when x increases from 1.9 to $1.9 + h$, where h is small. [6]

8 In this question, **i** is a unit vector due east and **j** is a unit vector due north. Distances are measured in kilometres and time is measured in hours.

At 09 00, ship A leaves a point P with position vector $5\mathbf{i}+16\mathbf{j}$ relative to an origin O. It sails with a constant speed of $6\sqrt{3}$ on a bearing of 120°.

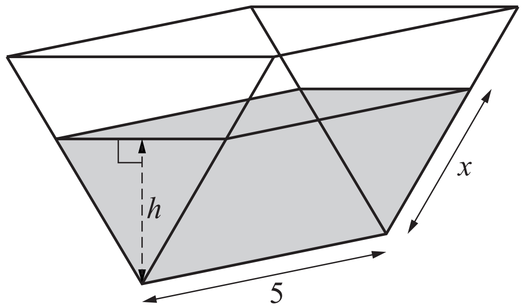
(a) Show that the velocity vector of A is $9\mathbf{i}-3\sqrt{3}\mathbf{j}$. [2]

(b) Find the position vector of A at 12 00. [1]

(c) At 11 00 ship B leaves a point Q with position vector $29\mathbf{i}+16\mathbf{j}$. It sails with constant velocity $-12\sqrt{3}\mathbf{j}$. Write down the position vector of B, t hours after it starts sailing. [1]

(d) Find the distance between the two ships at 12 00. [3]

9 In this question all lengths are in metres.



The diagram shows a water container in the shape of a triangular prism. The depth of water in the container is h. The container has length 5. The water in the container forms a prism with a uniform cross-section that is an equilateral triangle of side x.

(a) Show that the volume, V, of the water is given by $V = \frac{5\sqrt{3}h^2}{3}$. [4]

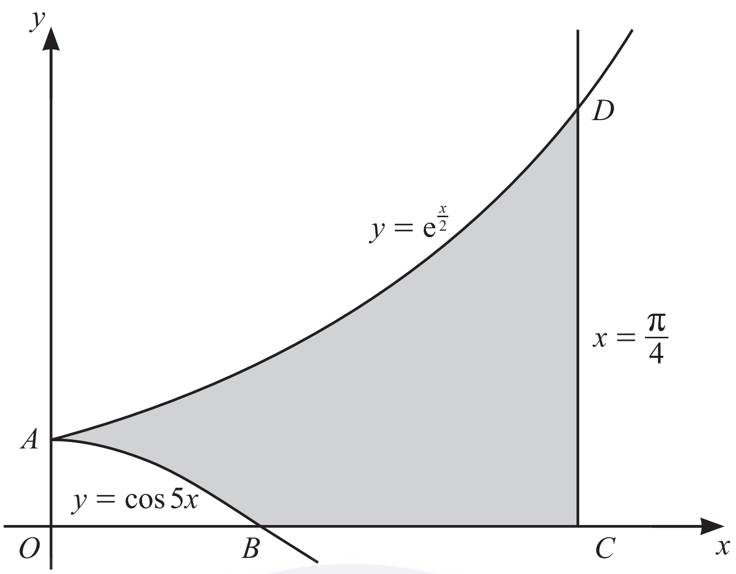
(b) Water is pumped into the container at a rate of $0.5\,\text{m}^3$ per minute. Find the rate at which the depth of the water is increasing when the depth of the water is 0.1 m. [4]

10 **(a)** Differentiate $x\ln x - 2x$ with respect to x. Simplify your answer. [2]

(b) A curve is such that $\dfrac{d^2y}{dx^2} = \left(\dfrac{x+1}{\sqrt{x}}\right)^2$. It is given that $\dfrac{dy}{dx} = \dfrac{e^2}{2} + 2e$ at the point $\left(e, \dfrac{e^3}{6} + e^2\right)$.
Using your answer to **part (a)**, find the exact equation of the curve. [8]

Question 11 is printed on the next page.

11



The diagram shows part of the curves $y = e^{\frac{x}{2}}$ and $y = \cos 5x$ and part of the line $x = \frac{\pi}{4}$. The curves intersect at A. The curve $y = \cos 5x$ cuts the x-axis at B. The line $x = \frac{\pi}{4}$ cuts the x-axis at C and the curve $y = e^{\frac{x}{2}}$ at D. Find the exact area of the shaded region, $ABCD$. [7]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1223544829

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2022**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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INFORMATION

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- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

DC (KN/SW) 303758/3

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

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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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

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Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

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

Formulae for ΔABC

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

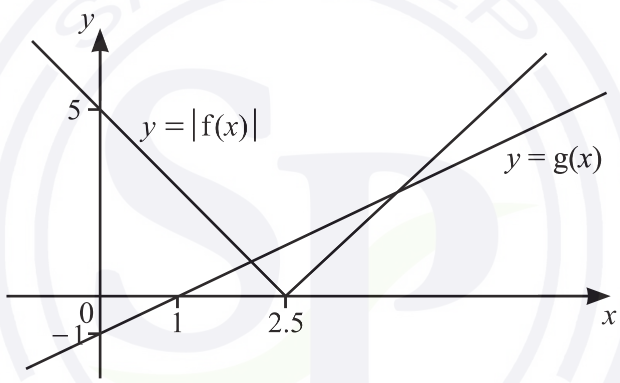
$$a^2 = b^2 + c^2 - 2bc\cos A$$

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

1 DO NOT USE A CALCULATOR IN THIS QUESTION.

A curve has equation $y = \dfrac{6+\sqrt{x}}{3+\sqrt{x}}$ where $x \geqslant 0$. Find the exact value of y when $x = 6$. Give your answer in the form $a + b\sqrt{c}$, where a, b and c are integers. [3]

2



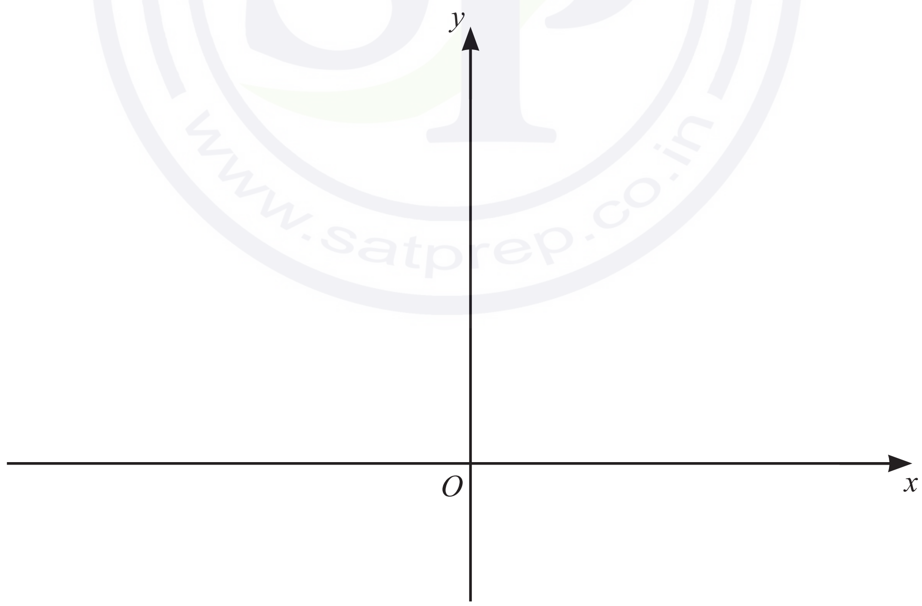
The diagram shows the graphs of $y = |\mathrm{f}(x)|$ and $y = \mathrm{g}(x)$, where $y = \mathrm{f}(x)$ and $y = \mathrm{g}(x)$ are straight lines. Solve the inequality $|\mathrm{f}(x)| \leqslant \mathrm{g}(x)$. [5]

3 Find the possible values of k for which the equation $kx^2 + (k+5)x - 4 = 0$ has real roots. [5]

4 Variables x and y are related by the equation $y = 1 + \frac{2}{x} + \frac{1}{x^2}$ where $x > 0$. Use differentiation to find the approximate change in x when y increases from 4 by the small amount 0.01. [5]

5 **(a)** Solve the equation $\dfrac{625^{\frac{x^3-1}{2}}}{125^{x^3}} = 5.$ [3]

(b) On the axes, sketch the graph of $y = 4e^x + 3$ showing the values of any intercepts with the coordinate axes. [2]



6 **(a)** In this question, **i** is a unit vector due east and **j** is a unit vector due north.

A cyclist rides at a speed of $4\,\text{ms}^{-1}$ on a bearing of 015°. Write the velocity vector of the cyclist in the form $x\mathbf{i} + y\mathbf{j}$, where x and y are constants. [2]

(b) A vector of magnitude 6 on a bearing of 300° is added to a vector of magnitude 2 on a bearing of 230° to give a vector **v**. Find the magnitude and bearing of **v**. [5]

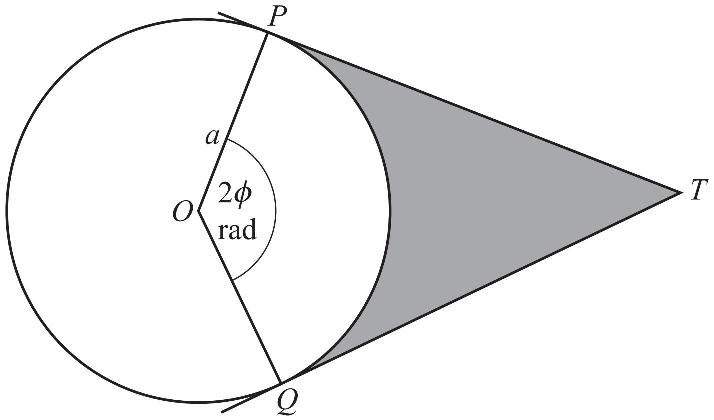
7 Differentiate $y = \dfrac{e^{4x}\tan x}{\ln x}$ with respect to x. [4]

8 The function f is defined by $f(x) = 3\sin^2 x - 2\cos x$ for $2 \leqslant x \leqslant 4$, where x is in radians.

(a) Find the x-coordinate of the stationary point on the curve $y = f(x)$. [5]

(b) Solve the equation $f(x) = 1 - 3\cos x$. [5]

9 In this question all lengths are in centimetres.



The diagram shows a circle, centre O, radius a. The lines PT and QT are tangents to the circle at P and Q respectively. Angle POQ is 2ϕ radians.

(a) In the case when the area of the sector OPQ is equal to the area of the shaded region, show that $\tan\phi = 2\phi$. [4]

(b) In the case when the perimeter of the sector *OPQ* is equal to half the perimeter of the shaded region, find an expression for $\tan\phi$ in terms of ϕ. [3]

10 **(a)** A geometric progression has first term a and common ratio r, where $r > 0$. The second term of this progression is 8. The sum of the third and fourth terms is 160.

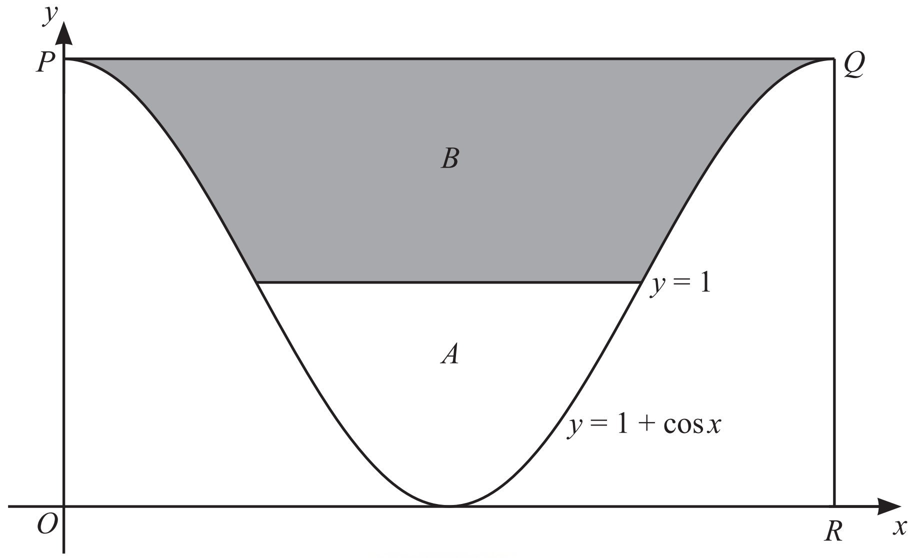
(i) Show that r satisfies the equation $r^2 + r - 20 = 0$. [4]

(ii) Find the value of a. [3]

(b) An arithmetic progression has first term p and common difference 2. The qth term of this progression is 14.
A different arithmetic progression has first term p and common difference 4. The sum of the first q terms of this progression is 168.

Find the values of p and q. [6]

11



The diagram shows part of the line $y = 1$ and one complete period of the curve $y = 1 + \cos x$, where x is in radians. The line PQ is a tangent to the curve at P and at Q. The line QR is parallel to the y-axis. Area A is enclosed by the line $y = 1$ and the curve. Area B is enclosed by the line $y = 1$, the line PQ and the curve.

Given that area A : area B is $1 : k$ find the exact value of k. [9]

Continuation of working space for Question 11.

Question 12 is printed on the next page.

12 A curve is such that $\dfrac{d^2y}{dx^2} = \left(\dfrac{\sqrt{x}+1}{\sqrt[4]{x}}\right)^2$. Given that the gradient of the curve is $\dfrac{4}{3}$ at the point $(1, -1)$, find the equation of the curve. [7]

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2585156821

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2022**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (RW/CGW) 214193/1

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 Solve the equation $4|7x-3|-5=9$. [3]

2 **DO NOT USE A CALCULATOR IN THIS QUESTION.**

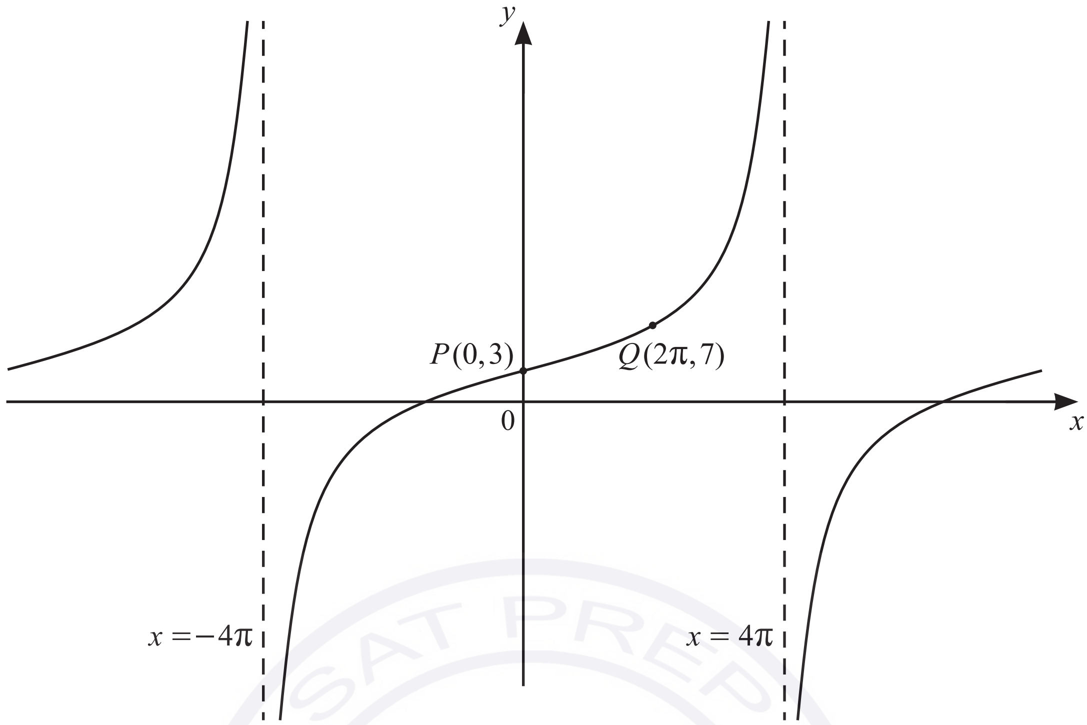
Variables x and y are related by the equation $y = kx^2$. When $x = 1+\sqrt{2}$, $y = 1-\sqrt{2}$. Find the value of k, giving your answer in the form $a+b\sqrt{c}$, where a, b and c are integers. [4]

3 The points A, B and C have coordinates (2, 6), (6, 1) and (p, q) respectively. Given that B is the mid-point of AC, find the equation of the line that passes through C and is perpendicular to AB. Give your answer in the form $ax + by = c$, where a, b and c are integers. [5]

4 **(a)** Find the range of values of x satisfying the inequality $(5x-1)(6-x) < 0$. [2]

(b) Show that the equation $(2k+1)x^2 - 4kx + 2k - 1 = 0$, where $k \neq -\frac{1}{2}$, has distinct, real roots. [3]

5



The diagram shows part of the graph of $y = a\tan bx + c$. The graph has vertical asymptotes at $x = -4\pi$ and $x = 4\pi$ and passes through the points P and Q.

(a) Write down the period of $a\tan bx + c$. [1]

(b) Find the values of a, b and c. [4]

6 The polynomial $\mathrm{p}(x)$ is such that $\mathrm{p}(x) = 6x^3 + ax^2 - 52x + b$, where a and b are integers. It is given that $\mathrm{p}(x)$ is divisible by $2x - 3$ and that $\mathrm{p}'(1) = 4$.

(a) Find the values of a and b. [5]

DO NOT USE A CALCULATOR IN THIS PART OF THE QUESTION.

(b) Using your values of a and b, factorise $\mathrm{p}(x)$ fully. [3]

7 **(a)** **(i)** Write down the set of values of x for which $\lg(5x-3)$ exists. [1]

(ii) Solve the equation $\lg(5x-3)=1$. [1]

(b) It is given that $\log_y x = 4 + \frac{1}{2}\log_y 64 + \log_y 162$, where $y > 0$. Find an expression for y in terms of x. Simplify your answer. [5]

8 **(a)** Differentiate $y = 2xe^{4x}$ with respect to x. [2]

(b) Hence find $\int xe^{4x}dx$. [4]

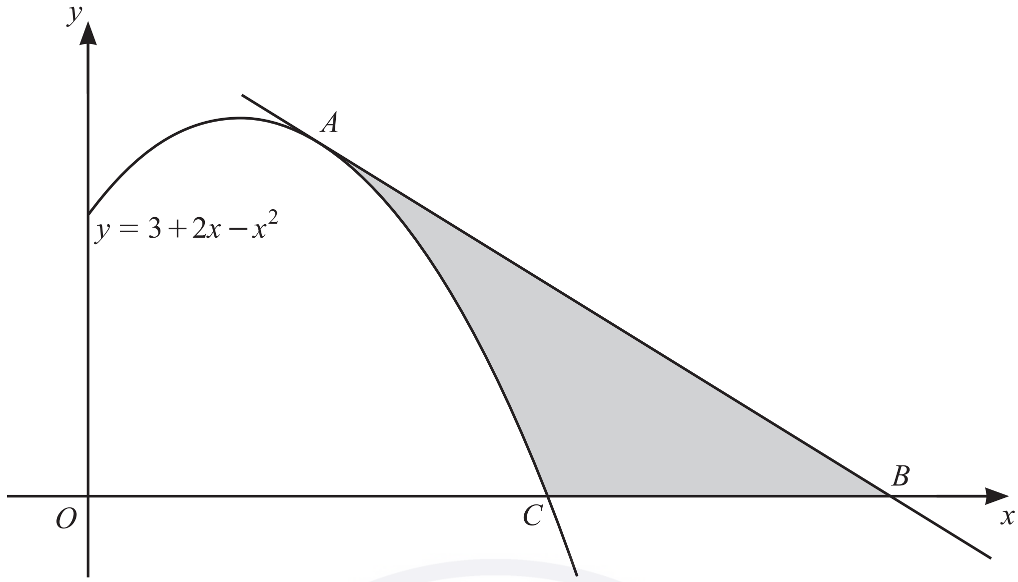
9 **(a)** Find the unit vector in the direction of $40\mathbf{i} - 9\mathbf{j}$. [2]

(b) The position vectors of points P and Q relative to an origin O are $\mathbf{p}$ and $\mathbf{q}$ respectively. The point R lies on the line PQ and is between P and Q such that $\frac{PR}{PQ} = k$.

(i) Write down the set of all possible values of k. [1]

(ii) Given that the position vector of R relative to O is $\lambda\mathbf{p} + \mu\mathbf{q}$ show that $\lambda + \mu = 1$. [3]

10



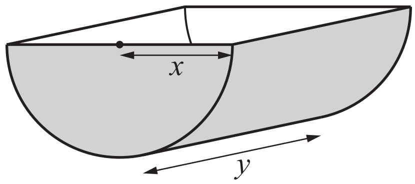
The diagram shows part of the curve $y = 3 + 2x - x^2$. The point A lies on the curve and has an x-coordinate of 1.5. The tangent to the curve at A meets the x-axis at B. The curve meets the x-axis at C. Find the area of the shaded region. [10]

Continuation of working space for Question 10.

11 (a) The sum of the first 20 terms of an arithmetic progression is 1100. The sum of the first 70 terms is 14350. Find the 12th term. [6]

(b) The first three terms of a geometric progression are $x+6$, $x-9$, $\frac{1}{2}(x+1)$. Show that x satisfies the equation $x^2-43x+156=0$. Hence show that a sum to infinity exists for each possible value of x. [7]

12 In this question all lengths are in centimetres.



A container is a half-cylinder, open as shown. It has length y and uniform cross-section of radius x. The volume of the container is 25 000. Given that x and y can vary and that the outer surface area, S, of the container has a minimum value, find this value. [8]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1704896938

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **February/March 2022**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (RW/CGW) 303976/2

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

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$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

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$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

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

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

1 A line, L, has equation $4x+5y=9$. Points A and B have coordinates $(-6, 7)$ and $(1, 9)$ respectively. Find the equation of the line parallel to L which passes through the mid-point of AB. [3]

2 Solve the equation $\log_5(8x+7)-\log_5 2x=2$. [3]

3 A group of students, 4 girls and 3 boys, stand in line.

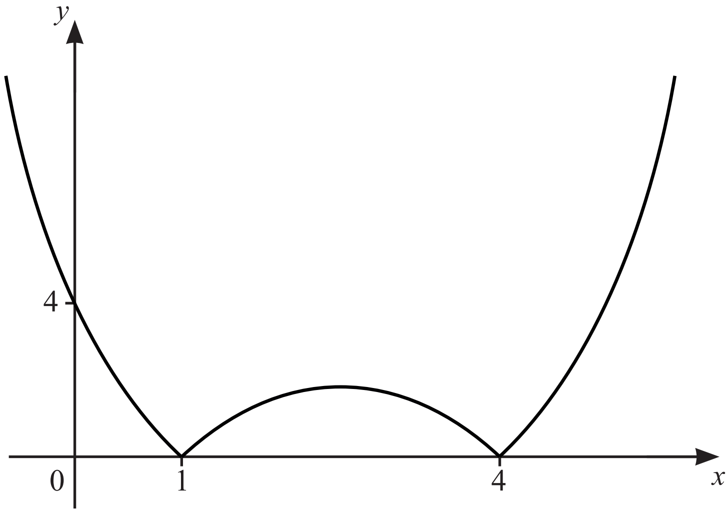
(a) Find the number of different ways the students can stand in line if there are no restrictions. [1]

(b) Find the number of different ways the students can stand in line if the 3 boys are next to each other. [2]

(c) Cam and Dea are 2 of the girls. Find the number of ways the students can stand in line if Cam and Dea are **not** next to each other. [2]

4 Find the x-coordinates of the points of intersection of the curves $\frac{x^2}{4}+\frac{y^2}{9}=1$ and $y=\frac{3}{2x}$.
Give your answers correct to 3 decimal places. [5]

5 **(a)**



The diagram shows the graph of $y = |f(x)|$, where $f(x)$ is a quadratic function. Write down the two possible expressions for $f(x)$. [2]

(b) The three roots of $p(x) = 0$, where $p(x) = 5x^3 + ax^2 + bx - 2$ are $x = \frac{1}{5}$, $x = n$ and $x = n+1$, where a and b are positive integers and n is a negative integer. Find $p(x)$, simplifying your coefficients. [5]

6 **(a)** **(i)** Use the binomial theorem to expand $(1+3x)^7$ in ascending powers of x, as far as the term in x^3. Simplify each term. [2]

(ii) Show that your expansion from **part (i)** gives the value of 1.03^7 as 1.23 to 2 decimal places. [2]

(b) Find the term independent of x in the expansion of $\left(\frac{x^4}{2}+\frac{2}{x}\right)^{15}$. [2]

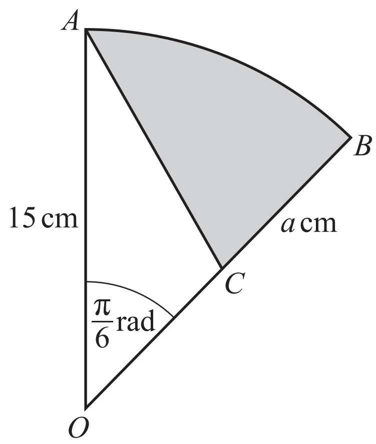
7 In this question, all angles are in radians.

(a) Solve the equation $\sec^2\theta = \tan\theta + 3$ for $-\pi < \theta < \pi$. [5]

(b) Show that, for $0 < \phi < \frac{\pi}{2}$, $\dfrac{\tan\phi}{\sqrt{1-\cos^2\phi}} = \sec\phi$. [3]

(c) Given that $\operatorname{cosec} x = -\frac{17}{8}$ and that $\frac{3\pi}{2} < x < 2\pi$, find the exact value of $\cot x$. [2]

8



The diagram shows the sector AOB of a circle, centre O and radius 15 cm. Angle AOB is $\frac{\pi}{6}$ radians. Point C lies on OB such that CB is a cm. AC is a straight line.

(a) Find the exact value of a such that the area of triangle AOC is equal to the area of the shaded region ACB. [4]

(b) For the value of a found in **part (a)**, find the perimeter of the shaded region. Give your answer correct to 1 decimal place. [3]

9 **(a)** A vehicle travels along a straight, horizontal road. At time $t = 0$ seconds, the vehicle, travelling at a velocity of $w\,\text{ms}^{-1}$, passes point O. The vehicle travels at this constant velocity for 12 seconds. It then slows down, with constant deceleration, for 10 seconds until it reaches a velocity of $(w-14)\,\text{ms}^{-1}$. It continues to travel at this velocity for 28 seconds until it reaches point A, 458 m from O.

Find the value of w. [4]

(b) A particle moves in a straight line. The velocity, $v\,\text{ms}^{-1}$, of the particle at time t seconds, where $t \geqslant 0$, is given by $v = (t-4)(t-5)$.

(i) Find the value of t for which the acceleration of the particle is $0\,\text{ms}^{-2}$. [2]

(ii) Find the set of values of t for which the velocity of the particle is negative. [2]

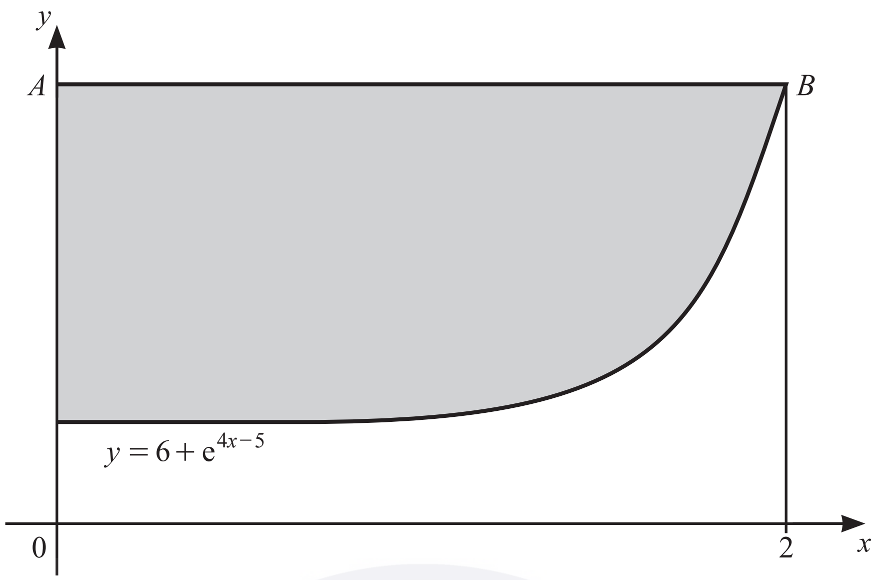
(iii) Find the distance travelled by the particle in the first 5 seconds of its motion. [4]

10 Relative to an origin O, the position vector of point P is $3\mathbf{i}-2\mathbf{j}$ and the position vector of point Q is $8\mathbf{i}+13\mathbf{j}$.

(a) The point R is such that $\overrightarrow{PQ}=5\overrightarrow{PR}$. Find the unit vector in the direction $\overrightarrow{OR}$. [5]

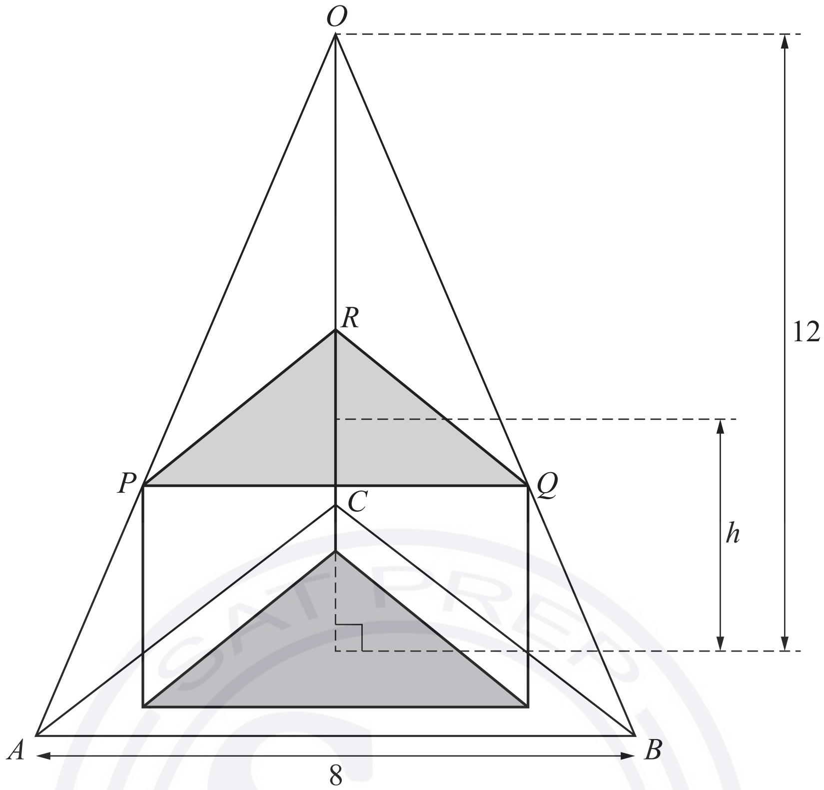
(b) The position vector of S relative to O is $\lambda\mathbf{j}$. Given that RS is parallel to PQ, find the value of λ. [3]

11



The diagram shows part of the graphs of $y = 6 + e^{4x-5}$ and $x = 2$. The line $x = 2$ meets the curve at the point $B(2, b)$ and the line AB is parallel to the x-axis. Find the area of the shaded region. [7]

12 In this question all lengths are in centimetres.



The diagram shows a right triangular prism of height h inside a right pyramid.
The pyramid has a height of 12 and a base that is an equilateral triangle, ABC, of side 8.
The base of the prism sits on the base of the pyramid.
Points P, Q and R lie on the edges OA, OB and OC, respectively, of the pyramid $OABC$.
Pyramids $OABC$ and $OPQR$ are similar.

(a) Show that the volume, V, of the triangular prism is given by $V = \frac{\sqrt{3}}{9}(ah^3 + bh^2 + ch)$ where a, b and c are integers to be found. [4]

(b) It is given that, as h varies, V has a maximum value. Find the value of h that gives this maximum value of V. [3]

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Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

7116278869

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2021**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
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INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (PQ/FC) 212424/3

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

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

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 Solve the inequality $(x+5)(x-2) > 3x+6$. [3]

2 Solve the following simultaneous equations.

$$xy + x^2 = 15$$

$$y + 3x = 11$$

[5]

3 A curve has equation $y = \dfrac{2 + \sin 3x}{x + 1}$.

(a) Show that the exact value of $\dfrac{dy}{dx}$ at the point where $x = \dfrac{\pi}{6}$ can be written as $\dfrac{k}{\left(\dfrac{\pi}{6} + 1\right)^2}$, where k is an integer. [5]

(b) Find the equation of the normal to the curve at the point where $x = 0$. [4]

4 Find rational values a and b such that $\dfrac{a}{\sqrt{5}+2}+\dfrac{b}{\sqrt{5}-2}=1$. [5]

5 It is given that $y = 3\tan^2 x$ for $0° < x < 360°$.

(a) Show that $\dfrac{dy}{dx} = m\tan x\sec^2 x$ where m is an integer to be found. [2]

(b) Find all values of x such that $\dfrac{dy}{dx} = 3\sec x\,\mathrm{cosec}\,x$. [5]

6 Find the values of m for which the line $y = mx - 2$ does not touch or cut the curve $y = (m+1)x^2 + 8x + 1$. [6]

7 **(a)** Use logarithms to solve the following equation, giving your answer correct to 1 decimal place.

$$5^{x-2} = 3 \times 2^{2x+3}$$ [4]

(b) Solve the equation $\log_3(y^2 + 11) - 2 = \log_3(y - 1)$. [5]

8 Marc chooses 5 people from 4 men, 4 women and 2 children.

Find the number of ways that Marc can do this

(a) if there are no restrictions, [1]

(b) if at least 2 men are chosen, [3]

(c) if at least 1 man, at least 1 woman and at least 1 child are chosen. [3]

9 The following functions are defined for $x > 1$.

$$f(x) = \frac{x+3}{x-1} \qquad g(x) = 1 + x^2$$

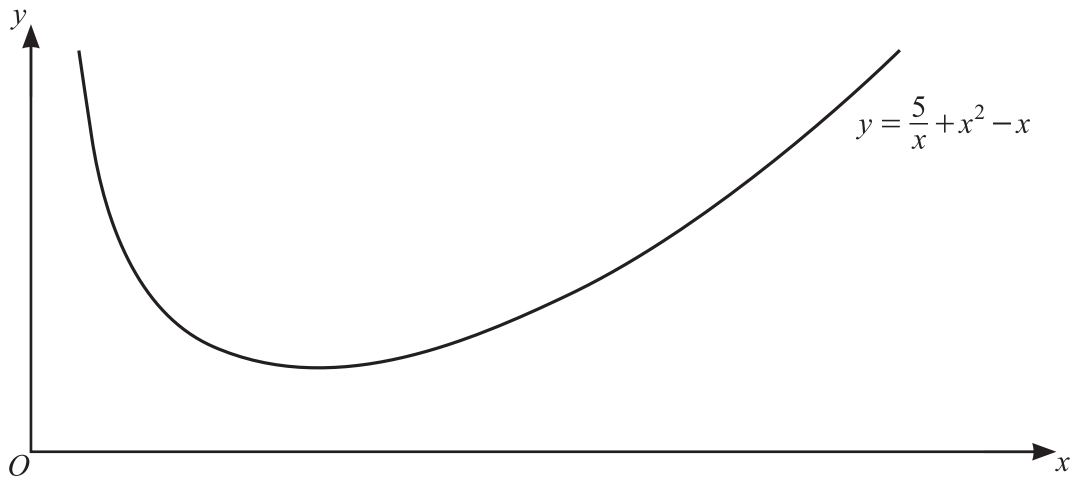
(a) Find $fg(x)$. [2]

(b) Find $g^{-1}(x)$. [2]

(c) DO NOT USE A CALCULATOR IN THIS PART OF THE QUESTION.

Solve the equation $f(x) = g(x)$. [5]

10



The diagram shows part of the curve $y = \frac{5}{x} + x^2 - x$.

(a) Find, in the form $y = mx + c$, the equation of the tangent to the curve at the point where $x = 1$. [5]

(b) Find the exact area enclosed by the curve, the x-axis, and the lines $x = 1$ and $x = 3$. [4]

11 The volume, V, of a cone with base radius r and vertical height h is given by $\frac{1}{3}\pi r^2 h$.
The curved surface area of a cone with base radius r and slant height l is given by $\pi r l$.

A cone has base radius r cm, vertical height h cm and volume V cm^3. The curved surface area of the cone is 4π cm^2.

(a) Show that $h^2 = \frac{16}{r^2} - r^2$. [4]

(b) Show that $V = \frac{\pi}{3}\sqrt{16r^2 - r^6}$. [2]

(c) Given that r can vary and that V has a maximum value, find the value of r that gives the maximum volume. [5]

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Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8550153025

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **October/November 2021**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (LK/FC) 212425/3

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
$$\sec^2 A = 1 + \tan^2 A$$
$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

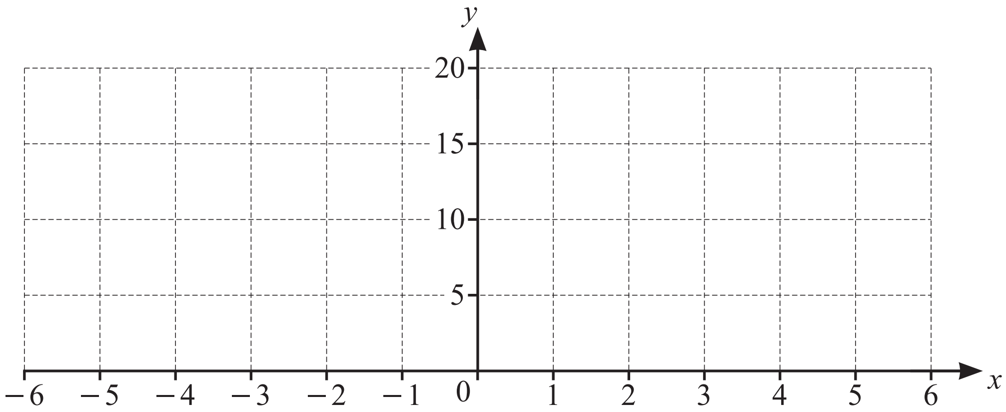
Formulae for ΔABC

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

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

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

1



(a) On the axes, draw the graphs of $y = 5 + |3x - 2|$ and $y = 11 - x$. [4]

(b) Using the graphs, or otherwise, solve the inequality $11 - x < 5 + |3x - 2|$. [2]

2 **(a)** Expand $(2-3x)^4$, evaluating all of the coefficients. [4]

(b) The sum of the first three terms in ascending powers of x in the expansion of $(2-3x)^4\left(1+\frac{a}{x}\right)$ is $\frac{32}{x}+b+cx$, where a, b and c are integers. Find the values of each of a, b and c. [4]

3 **(a)** Show that $\frac{1}{\sec x - 1} + \frac{1}{\sec x + 1} = 2\cot x \operatorname{cosec} x$. [4]

(b) Hence solve the equation $\frac{1}{\sec x - 1} + \frac{1}{\sec x + 1} = 3\sec x$ for $0° < x < 360°$. [4]

4 **(a)** Find the x-coordinates of the stationary points on the curve $y = 3\ln x + x^2 - 7x$, where $x > 0$. [5]

(b) Determine the nature of each of these stationary points. [3]

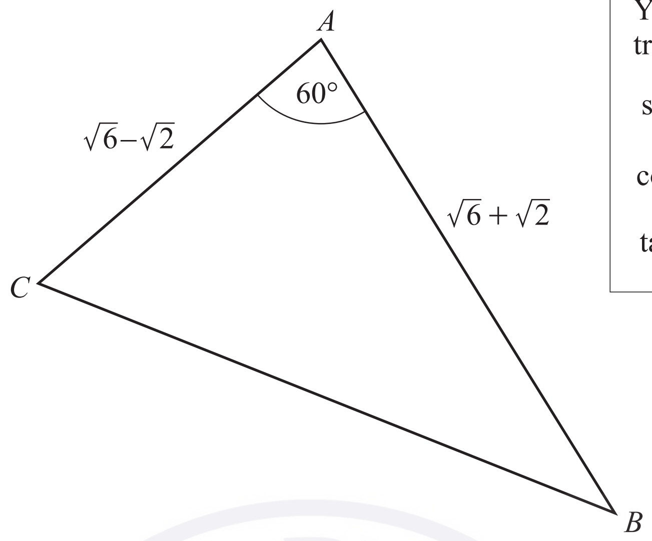
5 **(a)** Solve the following simultaneous equations.

$$e^{x} + e^{y} = 5$$
$$2e^{x} - 3e^{y} = 8$$

[5]

(b) Solve the equation $e^{(2t-1)} = 5e^{(5t-3)}$. [4]

6 DO NOT USE A CALCULATOR IN THIS QUESTION.
All lengths in this question are in centimetres.



You may use the following trigonometrical ratios.

$\sin 60° = \frac{\sqrt{3}}{2}$

$\cos 60° = \frac{1}{2}$

$\tan 60° = \sqrt{3}$

The diagram shows triangle ABC with $AC = \sqrt{6} - \sqrt{2}$, $AB = \sqrt{6} + \sqrt{2}$ and angle $CAB = 60°$.

(a) Find the exact length of BC. [3]

(b) Show that $\sin ACB = \dfrac{\sqrt{6} + \sqrt{2}}{4}$. [2]

(c) Show that the perpendicular distance from A to the line BC is 1. [2]

7 It is given that $\dfrac{d^2y}{dx^2} = e^{2x} + \dfrac{1}{(x+1)^2}$ for $x > -1$.

(a) Find an expression for $\dfrac{dy}{dx}$ given that $\dfrac{dy}{dx} = 2$ when $x = 0$. [3]

(b) Find an expression for y given that $y = 4$ when $x = 0$. [3]

8 Variables x and y are such that when $\sqrt{y}$ is plotted against $\log_2(x+1)$, where $x > -1$, a straight line is obtained which passes through $(2, 10.4)$ and $(4, 15.4)$.

(a) Find $\sqrt{y}$ in terms of $\log_2(x+1)$. [4]

(b) Find the value of y when $x = 15$. [1]

(c) Find the value of x when $y = 25$. [3]

9 **(a)** Find the equation of the normal to the curve $y = x^3 + x^2 - 4x + 6$ at the point $(1, 4)$. [5]

(b) DO NOT USE A CALCULATOR IN THIS PART OF THE QUESTION.

Find the exact x-coordinate of each of the two points where the normal cuts the curve again. [5]

10 **(a)** The first three terms of an arithmetic progression are x, $5x-4$ and $8x+2$. Find x and the common difference. [4]

(b) The first three terms of a geometric progression are y, $5y-4$ and $8y+2$.

(i) Find the two possible values of y. [4]

(ii) For each of these values of y, find the corresponding value of the common ratio. [2]

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Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3772962579

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2021**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
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- Do **not** write on any bar codes.
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- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (CE/CB) 212426/3

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
$$\sec^2 A = 1 + \tan^2 A$$
$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

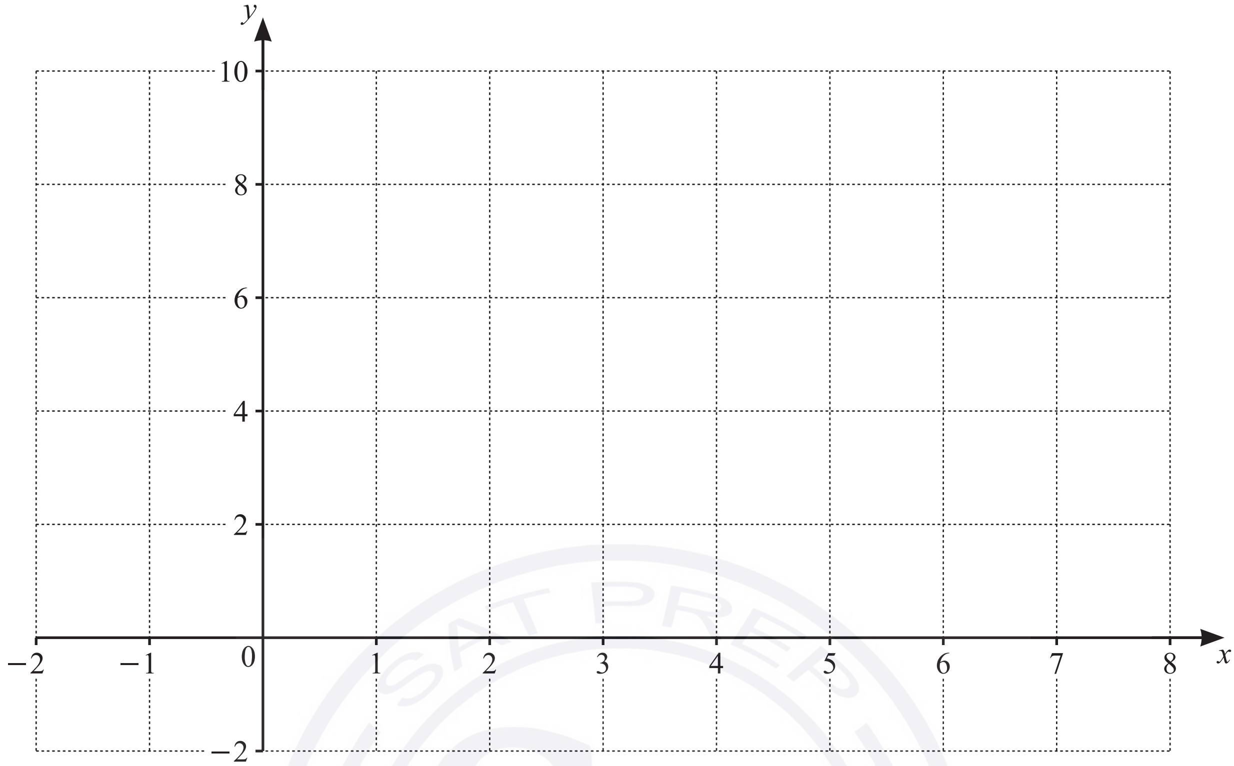
Formulae for ΔABC

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

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

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

1



(a) On the axes draw the graphs of $y = |x-5|$ and $y = 6-|2x-7|$. [4]

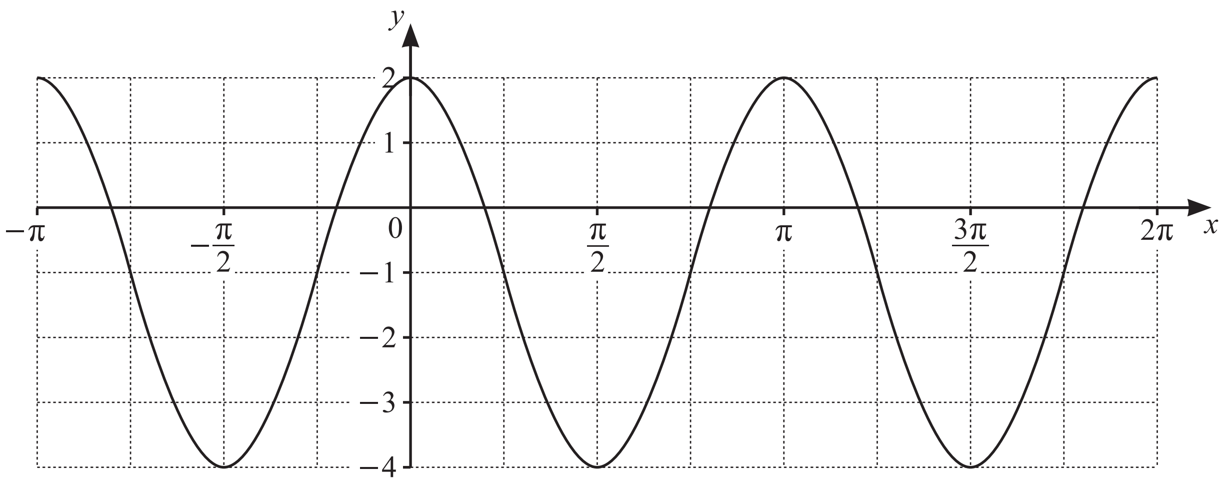
(b) Use your graphs to solve the inequality $|x-5| > 6-|2x-7|$. [2]

2 Solve the following simultaneous equations. Give your answers in the form $a+b\sqrt{3}$, where a and b are rational.

$$x+y=3$$
$$2x-\sqrt{3}y=5$$

[5]

3



(a) The curve has equation $y = a\cos bx + c$ where a, b and c are integers. Find the values of a, b and c. [3]

(b) Another curve has equation $y = 2\sin 3x + 4$. Write down

(i) the amplitude, [1]

(ii) the period in radians. [1]

4 **(a)** Solve the equation $\log_6(2x-3) = \frac{1}{2}$. Give your answer in exact form. [2]

(b) Solve the equation $\ln 2u - \ln(u-4) = 1$. Give your answer in exact form. [3]

(c) Solve the equation $\frac{3^v}{27^{2v-5}} = 9$. [3]

5 **(a)** Show that $\dfrac{1}{\operatorname{cosec} x - 1} + \dfrac{1}{\operatorname{cosec} x + 1} = 2\tan x \sec x$. [4]

(b) Hence solve the equation $\dfrac{1}{\operatorname{cosec} x - 1} + \dfrac{1}{\operatorname{cosec} x + 1} = 5\operatorname{cosec} x$ for $0° < x < 360°$. [4]

6 It is given that $x = 2 + \sec\theta$ and $y = 5 + \tan^2\theta$.

(a) Express y in terms of x. [2]

(b) Find $\frac{dy}{dx}$ in terms of x. [1]

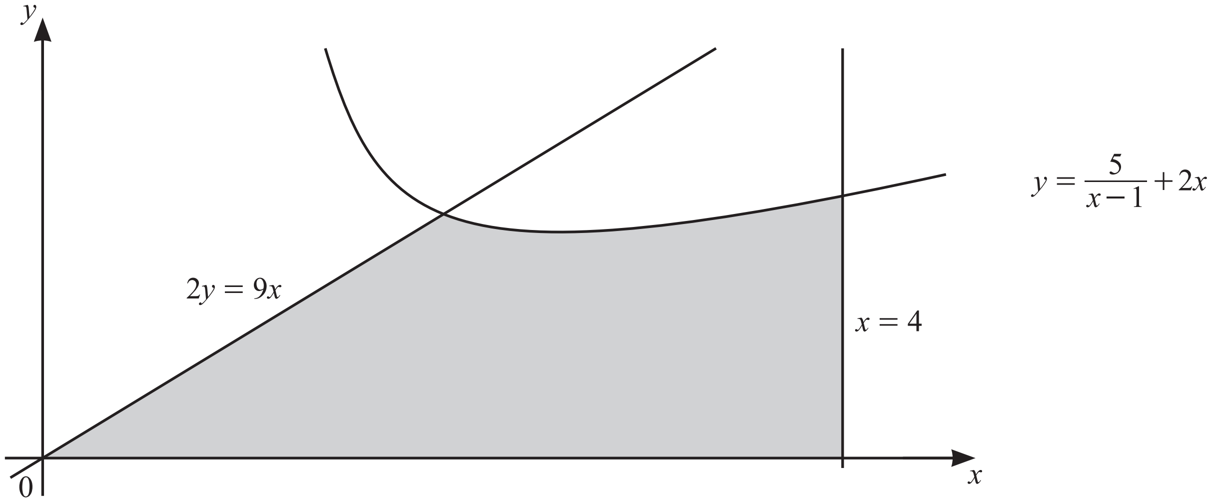
(c) A curve has the equation found in **part (a)**. Find the equation of the tangent to the curve when $\theta = \frac{\pi}{3}$. [4]

7 The vector **p** has magnitude 39 and is in the direction $-5\mathbf{i}+12\mathbf{j}$. The vector **q** has magnitude 34 and is in the direction $15\mathbf{i}-8\mathbf{j}$.

(a) Write both **p** and **q** in terms of **i** and **j**. [4]

(b) Find the magnitude of $\mathbf{p}+\mathbf{q}$ and the angle this vector makes with the positive x-axis. [4]

8



The diagram shows part of the curve $y = \dfrac{5}{x-1} + 2x$, and the straight lines $x = 4$ and $2y = 9x$.

(a) Find the coordinates of the stationary point on the curve $y = \dfrac{5}{x-1} + 2x$. [5]

(b) Given that the curve and the line $2y = 9x$ intersect at the point (2, 9), find the area of the shaded region. [5]

9 An arithmetic progression has first term a and common difference d. The third term is 13 and the tenth term is 41.

(a) Find the value of a and of d. [4]

(b) Find the number of terms required to give a sum of 2555. [4]

(c) Given that S_n is the sum to n terms, show that $S_{2k} - S_k = 3k(1+2k)$. [4]

10 **(a)** It is given that $f(x) = 4x^3 - 4x^2 - 15x + 18$. Find the equation of the normal to the curve $y = f(x)$ at the point where $x = 1$. [5]

(b) DO NOT USE A CALCULATOR IN THIS PART OF THE QUESTION.

It is also given that $x+a$, where a is an integer, is a factor of $f(x)$. Find a and hence solve the equation $f(x)=0$. [6]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9726863048

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2021**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (RW/SG) 202074/2

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 **(a)** Write the expression $x^2 - 6x + 1$ in the form $(x + a)^2 + b$, where a and b are constants. [2]

(b) Hence write down the coordinates of the minimum point on the curve $y = x^2 - 6x + 1$. [1]

2 Variables x and y are such that, when $\ln y$ is plotted against $\ln x$, a straight line graph passing through the points (6, 5) and (8, 9) is obtained. Show that $y = e^p x^q$ where p and q are integers. [4]

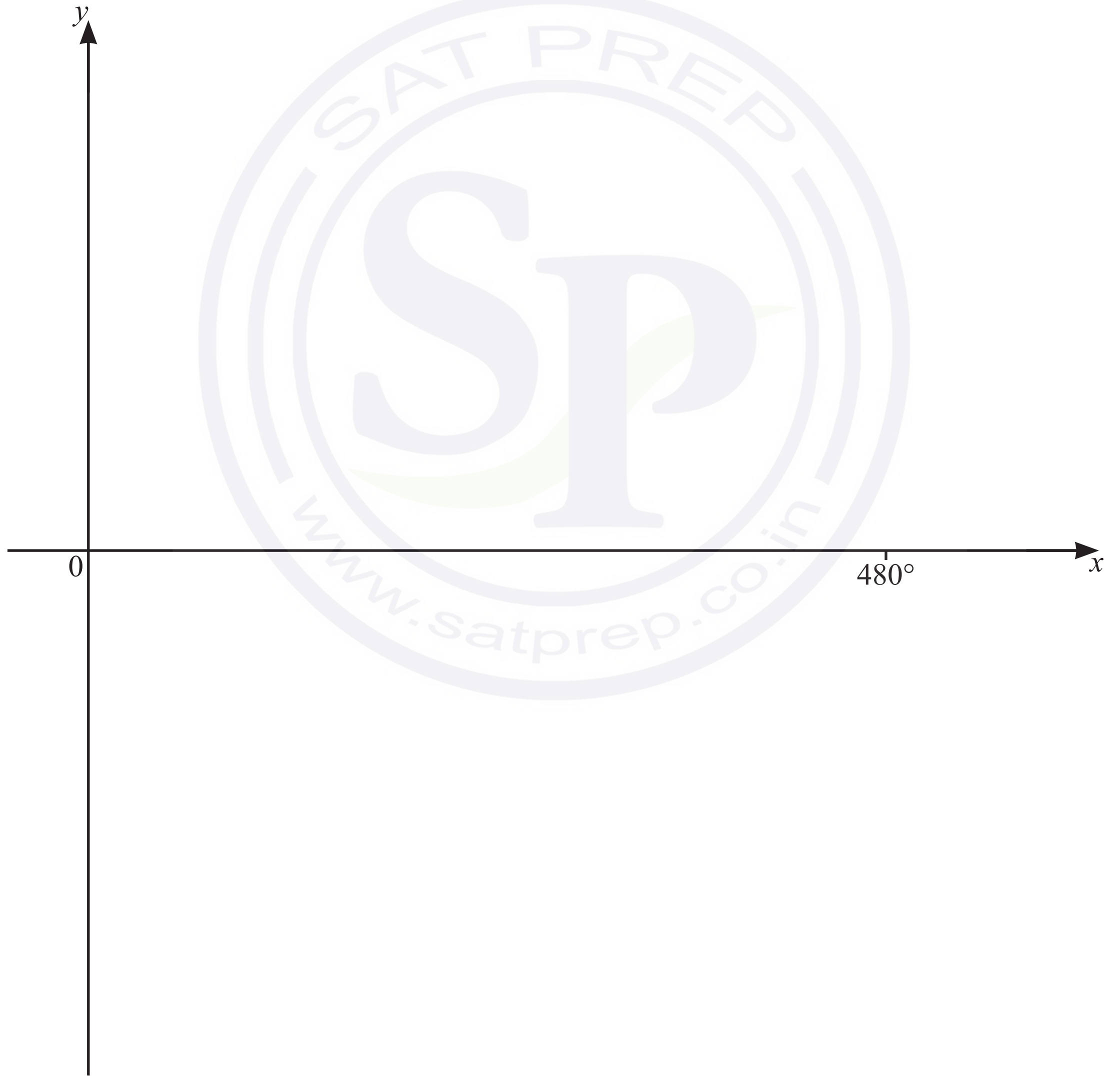
3 **(a)** Solve the inequality $|4x-1| > 9$. [3]

(b) Solve the equation $2x - 11\sqrt{x} + 12 = 0$. [3]

4 The graph of $y = a + 2\tan bx$, where a and b are constants, passes through the point $(0, -4)$ and has period 480°.

(a) Find the value of a and of b. [3]

(b) On the axes, sketch the graph of y for values of x between 0° and 480°. [2]



5 The curves $y = x^2$ and $y^2 = 27x$ intersect at $O(0, 0)$ and at the point A. Find the equation of the perpendicular bisector of the line OA. [8]

6 Variables x and y are such that $y = e^{\frac{x}{2}} + x\cos 2x$, where x is in radians. Use differentiation to find the approximate change in y as x increases from 1 to $1+h$, where h is small. [6]

7 Find the exact values of the constant k for which the line $y = 2x + 1$ is a tangent to the curve $y = 4x^2 + kx + k - 2$. [6]

8 In this question, a, b, c and d are positive constants.

(a) **(i)** It is given that $y = \log_a(x+3) + \log_a(2x-1)$. Explain why x must be greater than $\frac{1}{2}$. [1]

(ii) Find the exact solution of the equation $\frac{\log_a 6}{\log_a(y+3)} = 2$. [3]

(b) Write the expression $\log_a 9 + (\log_a b)(\log_{\sqrt{b}} 9a)$ in the form $c + d\log_a 9$, where c and d are integers. [4]

9 A curve is such that $\frac{d^2y}{dx^2} = \sin\left(6x - \frac{\pi}{2}\right)$. Given that $\frac{dy}{dx} = \frac{1}{2}$ at the point $\left(\frac{\pi}{4}, \frac{13\pi}{12}\right)$ on the curve, find the equation of the curve. [7]

10 Relative to an origin O, the position vectors of the points A, B, C and D are

$$\overrightarrow{OA} = \begin{pmatrix} 6 \\ -5 \end{pmatrix},\ \overrightarrow{OB} = \begin{pmatrix} 10 \\ 3 \end{pmatrix},\ \overrightarrow{OC} = \begin{pmatrix} x \\ y \end{pmatrix} \text{ and } \overrightarrow{OD} = \begin{pmatrix} 12 \\ 7 \end{pmatrix}.$$

(a) Find the unit vector in the direction of $\overrightarrow{AB}$. [3]

(b) The point A is the mid-point of BC. Find the value of x and of y. [2]

(c) The point E lies on OD such that $OE : OD$ is $1 : 1+\lambda$. Find the value of λ such that $\overrightarrow{BE}$ is parallel to the x-axis. [3]

11 The 2nd, 8th and 44th terms of an arithmetic progression form the first three terms of a geometric progression. In the arithmetic progression, the first term is 1 and the common difference is positive.

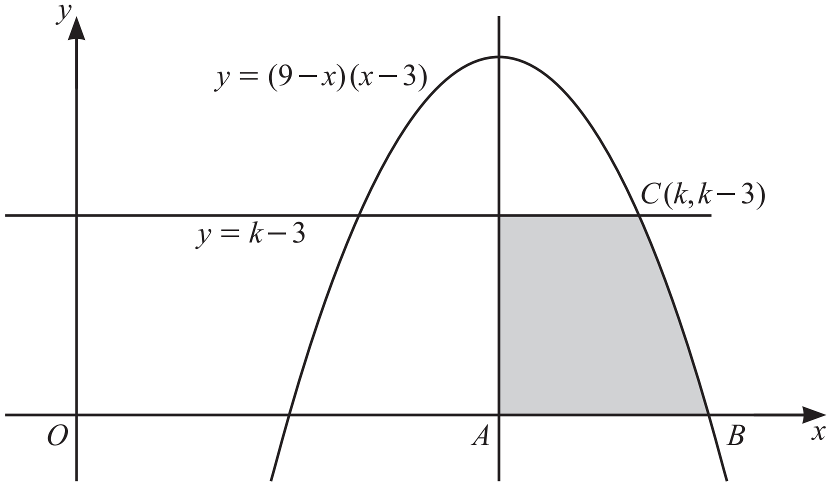
(a) **(i)** Show that the common difference of the arithmetic progression is 5. [5]

(ii) Find the sum of the first 20 terms of the arithmetic progression. [2]

(b) **(i)** Find the 5th term of the geometric progression. [2]

(ii) Explain whether or not the sum to infinity of this geometric progression exists. [1]

12



The diagram shows part of the curve $y = (9-x)(x-3)$ and the line $y = k-3$, where $k > 3$. The line through the maximum point of the curve, parallel to the y-axis, meets the x-axis at A. The curve meets the x-axis at B, and the line $y = k-3$ meets the curve at the point $C(k,\ k-3)$. Find the area of the shaded region. [9]

Continuation of working space for Question 12.

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Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4371182274

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2021**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
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- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
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INFORMATION

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- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

DC (RW/SG) 202073/2

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

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

Arithmetic series $u_n = a + (n-1)d$

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2. TRIGONOMETRY

Identities

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Formulae for ΔABC

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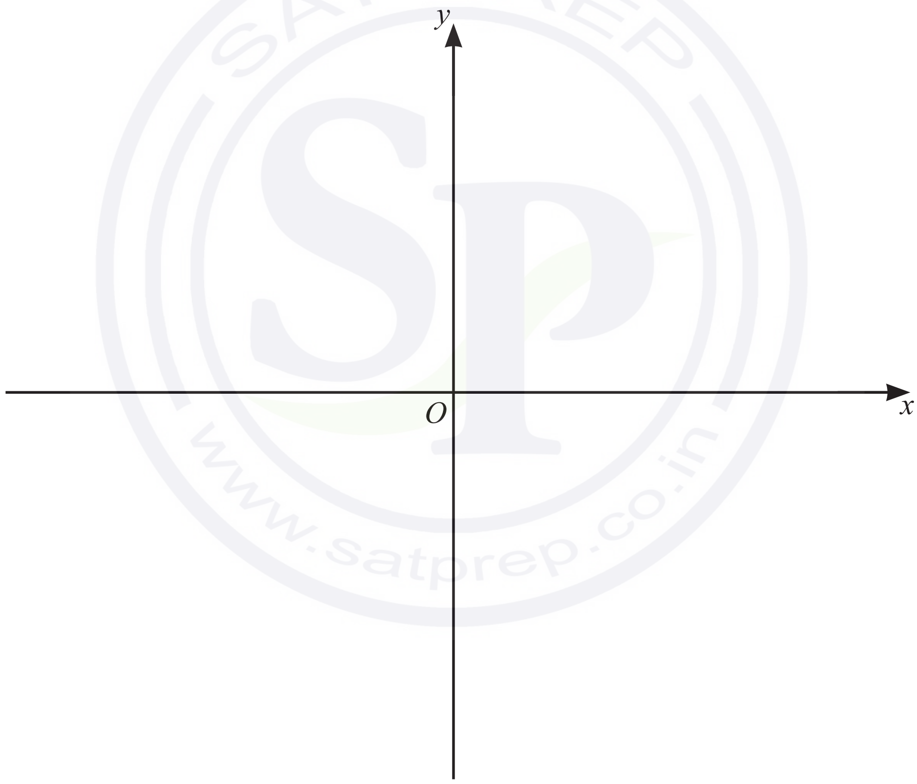
$$a^2 = b^2 + c^2 - 2bc\cos A$$

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

1 Using the binomial theorem, expand $(1+e^{2x})^4$, simplifying each term. [2]

2 On the axes, sketch the graph of $y = 3(x-3)(x-1)(x+2)$ stating the intercepts with the coordinate axes. [3]



3 Find the values of the constant k for which $(2k-1)x^2+6x+k+1=0$ has real roots. [5]

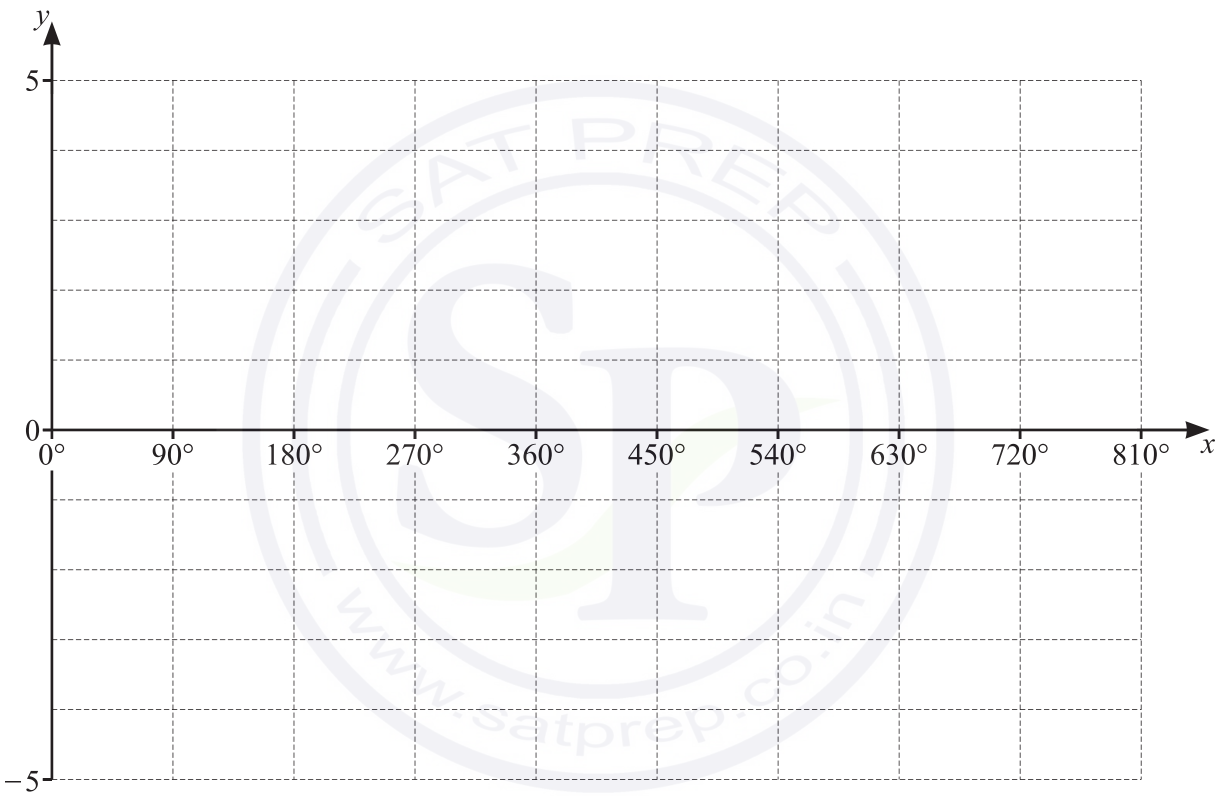
4 The polynomial $p(x) = mx^3 - 29x^2 + 39x + n$, where m and n are constants, has a factor $3x - 1$, and remainder 6 when divided by $x - 1$. Show that $x - 2$ is a factor of $p(x)$. [6]

5 The function f is defined, for $0° \leqslant x \leqslant 810°$, by $\mathrm{f}(x) = -2 + \cos\frac{2x}{3}$.

(a) Write down the amplitude of f. [1]

(b) Find the period of f. [2]

(c) On the axes, sketch the graph of $y = \mathrm{f}(x)$. [2]



6 The points $A(5, -4)$ and $C(11, 6)$ are such that AC is the diagonal of a square, $ABCD$.

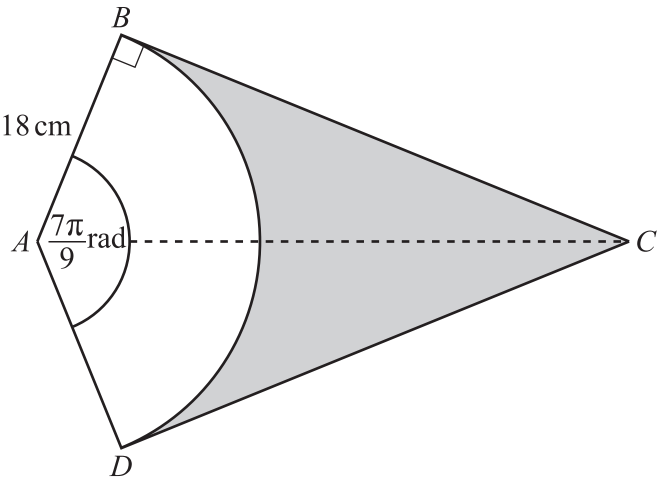
(a) Find the length of the line AC. [2]

(b) **(i)** The coordinates of the centre, E, of the square are $(8, y)$. Find the value of y. [1]

(ii) Find the equation of the diagonal BD. [3]

(iii) Given that the x-coordinate of B is less than the x-coordinate of D, write $\overrightarrow{EB}$ and $\overrightarrow{ED}$ as column vectors. [2]

7



DAB is a sector of a circle, centre *A*, radius 18 cm. The lines *CB* and *CD* are tangents to the circle. Angle *DAB* is $\frac{7\pi}{9}$ radians.

(a) Find the perimeter of the shaded region. [3]

(b) Find the area of the shaded region. [3]

8 A particle moves in a straight line so that, t seconds after passing through a fixed point O, its velocity, $v\,\text{ms}^{-1}$, is given by $v = 3t^2 - 30t + 72$.

(a) Find the distance between the particle's two positions of instantaneous rest. [6]

(b) Find the acceleration of the particle when $t = 2$. [2]

9 Solve the following simultaneous equations.

$$4x^2 + 3xy + y^2 = 8$$
$$xy + 4 = 0$$

[6]

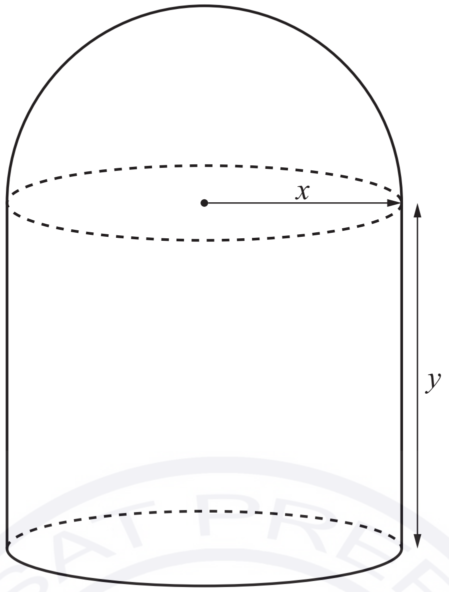
10 **(a)** Find $\int (e^{x+1})^3 \, dx$. [2]

(b) **(i)** Differentiate, with respect to x, $y = x \sin 4x$. [2]

(ii) Hence show that $\int_{\frac{\pi}{4}}^{\frac{\pi}{3}} 4x \cos 4x \, dx = \frac{1}{8} - \frac{\pi\sqrt{3}}{6}$. [4]

11 In this question all lengths are in centimetres.

The volume and surface area of a sphere of radius r are $\frac{4}{3}\pi r^3$ and $4\pi r^2$ respectively.

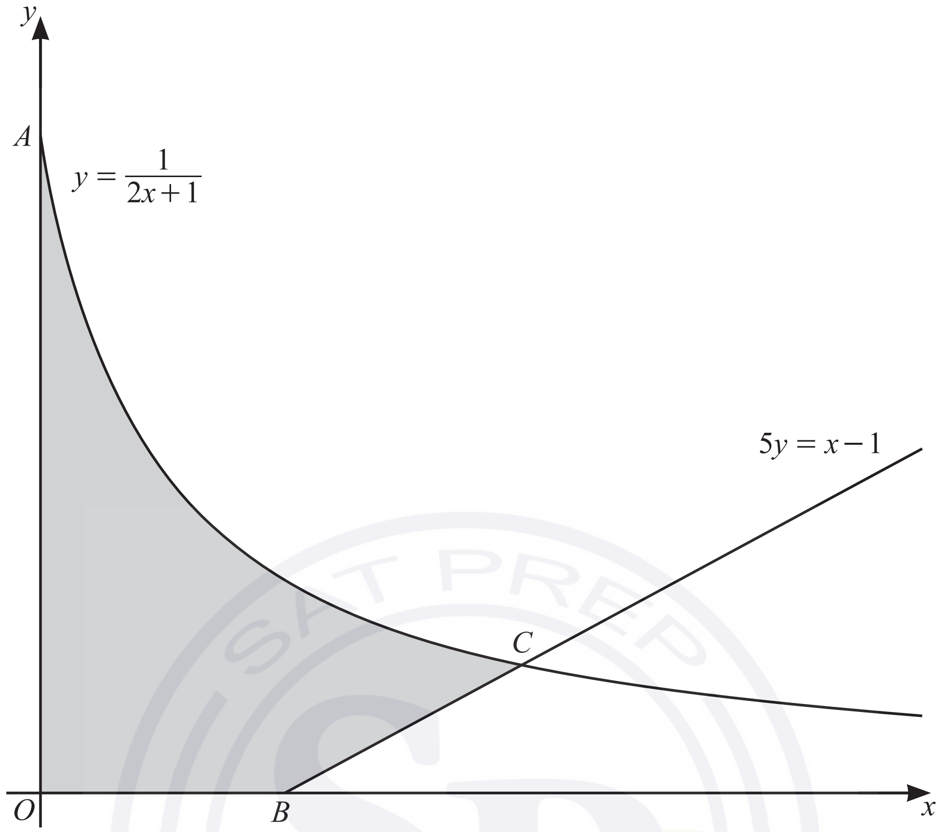


The diagram shows a solid object made from a hemisphere of radius x and a cylinder of radius x and height y. The volume of the object is $500\,\text{cm}^3$.

(a) Find an expression for y in terms of x and show that the surface area, S, of the object is given by $S = \frac{5}{3}\pi x^2 + \frac{1000}{x}$. [4]

(b) Given that x can vary and that S has a minimum value, find the value of x for which S is a minimum. [4]

12 DO NOT USE A CALCULATOR IN THIS QUESTION.



The diagram shows part of the curve $y = \frac{1}{2x+1}$ and part of the line $5y = x - 1$.

The curve meets the y-axis at point A. The line meets the x-axis at point B. The line and curve intersect at point C.

(a) **(i)** Find the coordinates of A and B. [1]

(ii) Verify that the x-coordinate of C is 2. [2]

(b) Find the exact area of the shaded region. [5]

Question 13 is printed on the next page.

13 The functions f and g are defined, for $x > 0$, by

$$f(x) = \frac{2x^2 - 1}{3x},$$
$$g(x) = \frac{1}{x}.$$

(a) Find and simplify an expression for $fg(x)$. [2]

(b) **(i)** Given that f^{-1} exists, write down the range of f^{-1}. [1]

(ii) Show that $f^{-1}(x) = \dfrac{px + \sqrt{qx^2 + r}}{4}$, where p, q and r are integers. [4]

Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2417627705

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2021**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION
- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (RW/SG) 202072/3

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 $\binom{n}{r} = \dfrac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 **DO NOT USE A CALCULATOR IN THIS QUESTION.**

Write $\dfrac{4-\sqrt{5}}{7-3\sqrt{5}}$ with a rational denominator, simplifying your answer. [3]

2 Given that $y = 2(7^{2x}) - 3(7^{x+1}) + 19$, find the value of x when $y = 30$. [4]

3 **(a)** Write $\dfrac{x(27xy^3)^{\frac{5}{3}}}{\sqrt[4]{81y^5}}$ in the form $3^a \times x^b \times y^c$ where a, b and c are constants. [3]

(b) **(i)** Find the value of a such that $2\log_a 8 = \dfrac{3}{2}$. [2]

(ii) Write $\log_{(a^2)} 3a$ as a single logarithm to base a. [2]

4 Variables x and y are such that $y = \frac{\sin x}{\cos x}$. Using differentiation, find the approximate change in y as x increases from $-\frac{\pi}{4}$ to $h - \frac{\pi}{4}$, where h is small. [4]

5 **(a)** Solve the inequality $2x^2 - 17x + 21 \leqslant 0$. [3]

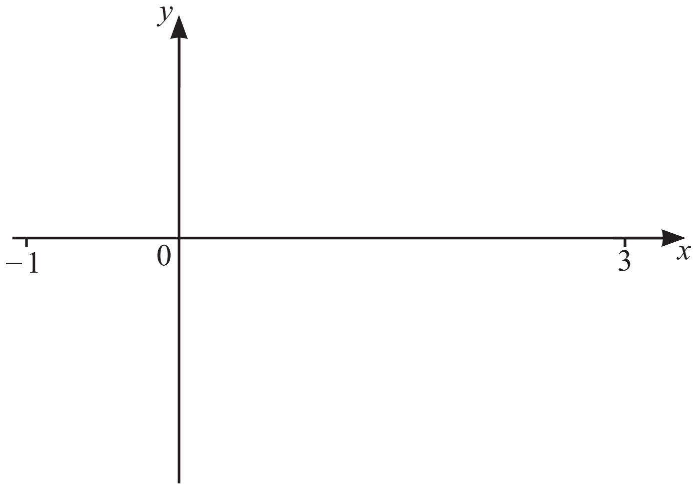
(b) Hence find the area enclosed between the curve $y = 2x^2 - 17x + 21$ and the x-axis. [3]

6 The polynomial p is given by $p(x) = 36x^3 - 15x^2 - 2x + 1$.

(a) Show that $x = -0.25$ is a root of the equation $p(x) = 0$. [1]

(b) Show that the equation $p(x) = 0$ has a repeated root. [4]

7 **(a)** Sketch the graph of the curve $y = \ln(4x-3)$ on the axes, stating the intercept with the x-axis. [2]



(b) Find the equation of the tangent to the curve $y = \ln(4x-3)$ at the point where $x = 2$. [5]

8 **(a)** **(i)** Find $\int \sin\left(\frac{\phi+\pi}{3}\right)\mathrm{d}\phi$. [2]

(ii) Find $\int (5\sin^2\theta + 5\cos^2\theta)\,\mathrm{d}\theta$. [2]

(b) Show that $\int_1^{\mathrm{e}} \left(\left(1+\frac{1}{x}\right)^2 - 1\right)\mathrm{d}x = \frac{3\mathrm{e}-1}{\mathrm{e}}$. [4]

9 **(a)** The function f is defined, for all real x, by $\mathrm{f}(x) = 13 - 4x - 2x^2$.

(i) Write $\mathrm{f}(x)$ in the form $a + b(x+c)^2$, where a, b and c are constants. [3]

(ii) Hence write down the range of f. [1]

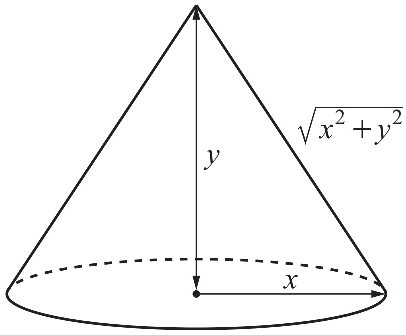
(b) The function g is defined, for $x \geqslant 1$, by $\mathrm{g}(x) = \sqrt{x^2 + 2x - 1}$.

(i) Given that $\mathrm{g}^{-1}(x)$ exists, write down the domain and range of g^{-1}. [2]

(ii) Show that $\mathrm{g}^{-1}(x) = -1 + \sqrt{px^2 + q}$, where p and q are integers. [4]

10 In this question all lengths are in centimetres.

The volume and curved surface area of a cone of base radius r, height h and sloping edge l are $\frac{1}{3}\pi r^2 h$ and πrl respectively.



The diagram shows a cone of base radius x, height y and sloping edge $\sqrt{x^2+y^2}$. The volume of the cone is 10π.

(a) Find an expression for y in terms of x and show that the curved surface area, S, of the cone is given by $S = \dfrac{\pi\sqrt{x^6+900}}{x}$. [3]

(b) Given that x can vary and that S has a minimum value, find the exact value of x for which S is a minimum. [5]

11 **(a)** The first three terms of an arithmetic progression are $\frac{1}{p}$, $\frac{1}{q}$, $-\frac{1}{q}$.

(i) Show that the common difference can be written as $-\frac{2}{3p}$. [3]

(ii) The 10th term of the progression is $\frac{k}{p}$, where k is a constant. Find the value of k. [2]

(b) The sum to infinity of a geometric progression is 8. The second term of the progression is $\frac{3}{2}$. Find the two possible values of the common ratio. [5]

12 A particle moves in a straight line such that its displacement, s metres, from a fixed point O at time t seconds, is given by $s = 2 + t - 2\cos t$, for $t \geqslant 0$.

(a) Find the displacement of the particle from O at the time when it first comes to instantaneous rest. [5]

(b) Find the time when the particle next comes to rest. [1]

(c) Find the distance travelled by the particle for $0 \leqslant t \leqslant \frac{3\pi}{2}$. [2]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2436662856

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **February/March 2021**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
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- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

DC (CE/SW) 202023/5

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
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Formulae for ΔABC

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

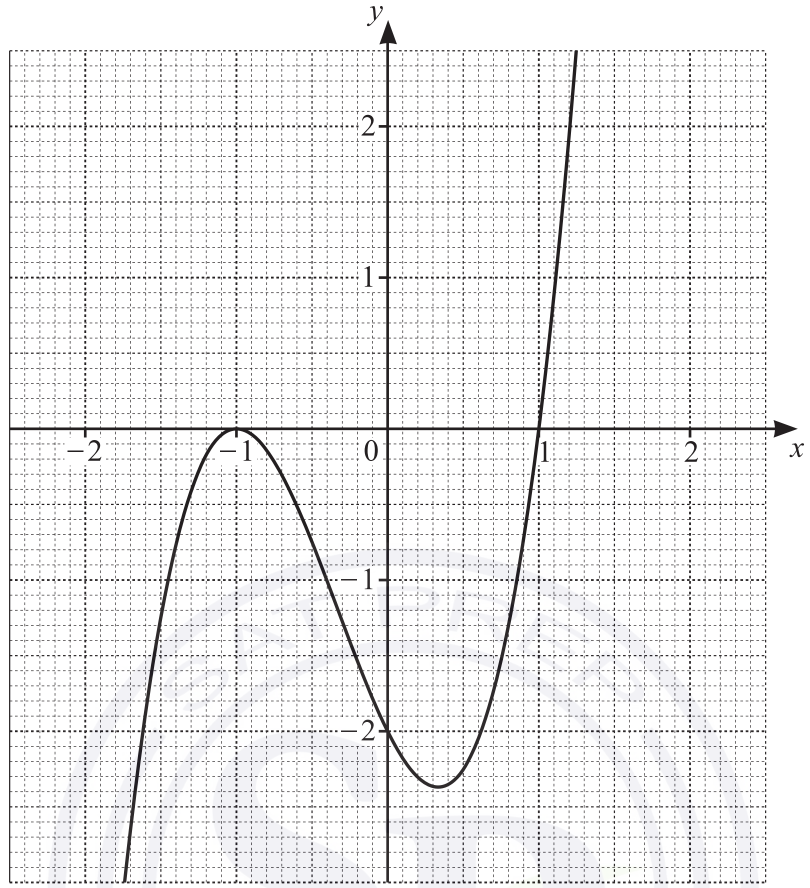
$$a^2 = b^2 + c^2 - 2bc\cos A$$

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

1 Solve the equation $|4x+9| = |6-5x|$. [3]

2 Find the values of the constant k for which the equation $kx^2 - 3(k+1)x + 25 = 0$ has equal roots. [4]

3



The diagram shows the graph of $y = \mathrm{f}(x)$, where $\mathrm{f}(x) = a(x+b)^2(x+c)$ and a, b and c are integers.

(a) Find the value of each of a, b and c. [2]

(b) Hence solve the inequality $\mathrm{f}(x) \leqslant -1$. [3]

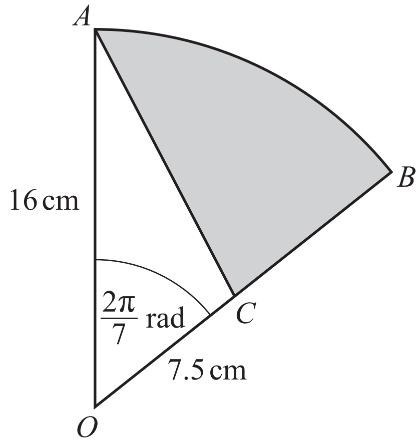
4 The curve $\frac{4}{x^2}+\frac{5}{4y^2}=1$ and the line $x+2y=0$ intersect at two points. Find the exact distance between these points. [6]

5 A cube of side x cm has surface area $S\,\text{cm}^2$. The volume, $V\,\text{cm}^3$, of the cube is increasing at a rate of $480\,\text{cm}^3\text{s}^{-1}$. Find, at the instant when $V = 512$,

(a) the rate of increase of x, [4]

(b) the rate of increase of S. [2]

6



AOB is a sector of a circle with centre *O* and radius 16 cm. Angle *AOB* is $\frac{2\pi}{7}$ radians. The point *C* lies on *OB* such that *OC* is of length 7.5 cm and *AC* is a straight line.

(a) Find the perimeter of the shaded region. [3]

(b) Find the area of the shaded region. [3]

7 A curve has equation $y = \mathrm{p}(x)$, where $\mathrm{p}(x) = x^3 - 4x^2 + 6x - 1$.

(a) Find the equation of the tangent to the curve at the point (3, 8). Give your answer in the form $y = mx + c$. [5]

(b) (i) Given that p^{-1} exists, write down the gradient of the tangent to the curve $y = \mathrm{p}^{-1}(x)$ at the point (8, 3). [1]

(ii) Find the coordinates of the point of intersection of these two tangents. [2]

8 A photographer takes 12 different photographs. There are 3 of sunsets, 4 of oceans, and 5 of mountains.

(a) The photographs are arranged in a line on a wall.

(i) How many possible arrangements are there if there are no restrictions? [1]

(ii) How many possible arrangements are there if the first photograph is of a sunset and the last photograph is of an ocean? [2]

(iii) How many possible arrangements are there if all the photographs of mountains are next to each other? [2]

(b) Three of the photographs are to be selected for a competition.

(i) Find the number of different possible selections if no photograph of a sunset is chosen. [2]

(ii) Find the number of different possible selections if one photograph of each type (sunset, ocean, mountain) is chosen. [2]

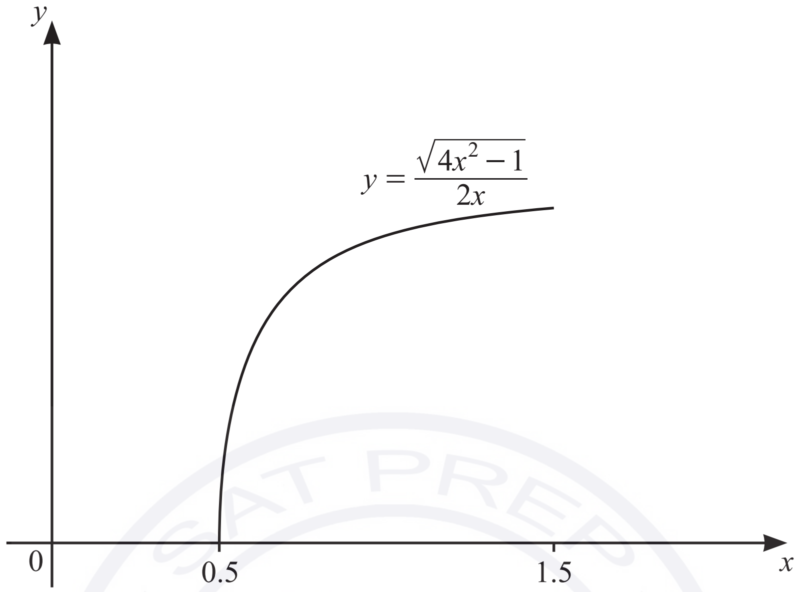
9 **(a)** In the expansion of $\left(2k-\frac{x}{k}\right)^5$, where k is a constant, the coefficient of x^2 is 160. Find the value of k. [3]

(b) **(i)** Find, in ascending powers of x, the first 3 terms in the expansion of $\left(1+3x\right)^6$, simplifying the coefficient of each term. [2]

(ii) When $(1+3x)^6(a+x)^2$ is written in ascending powers of x, the first three terms are $4+68x+bx^2$, where a and b are constants. Find the value of a and of b. [3]

10 The function f is defined by $f(x) = \dfrac{\sqrt{4x^2 - 1}}{2x}$ for $0.5 \leqslant x \leqslant 1.5$.

The diagram shows a sketch of $y = f(x)$.



(a) **(i)** It is given that f^{-1} exists. Find the domain and range of f^{-1}. [3]

(ii) Find an expression for $f^{-1}(x)$. [3]

(b) The function g is defined by $g(x) = e^{x^2}$ for all real x. Show that $gf(x) = e^{\left(1-\frac{a}{bx^2}\right)}$, where a and b are integers. [2]

11 **(a)** **(i)** Find $\int \frac{1}{(10x-1)^6} \mathrm{d}x$. [2]

(ii) Find $\int \frac{(2x^3+5)^2}{x} \mathrm{d}x$. [3]

(b) (i) Differentiate $y = \tan(3x+1)$ with respect to x. [2]

(ii) Hence find $\int_{\frac{\pi}{12}}^{\frac{\pi}{10}} \left(\frac{\sec^2(3x+1)}{2} - \sin x \right) dx$. [4]

Question 12 is printed on the next page.

12 A particle P travels in a straight line so that, t seconds after passing through a fixed point O, its velocity, $v\,\mathrm{ms}^{-1}$, is given by

$$v = \frac{t}{2\mathrm{e}} \qquad \text{for } 0 \leqslant t \leqslant 2,$$

$$v = \mathrm{e}^{-\frac{t}{2}} \qquad \text{for } t > 2\,.$$

Given that, after leaving O, particle P is never at rest, find the distance it travels between $t = 1$ and $t = 3$. [6]

Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8320369122

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2020**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
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INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Blank pages are indicated.

DC (LK/SG) 187994/3

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 $\binom{n}{r} = \frac{n!}{(n-r)!\,r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
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$$\text{cosec}^2 A = 1 + \cot^2 A$$

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 Solve the inequality $|3x+2| > 8+x$. [3]

2 Find the coordinates of the points of intersection of the curve $x^2 + xy = 9$ and the line $y = \frac{2}{3}x - 2$. [5]

3 Write $3\lg x + 2 - \lg y$ as a single logarithm. [3]

4 It is given that $y = \ln(\sin x + 3\cos x)$ for $0 < x < \frac{\pi}{2}$.

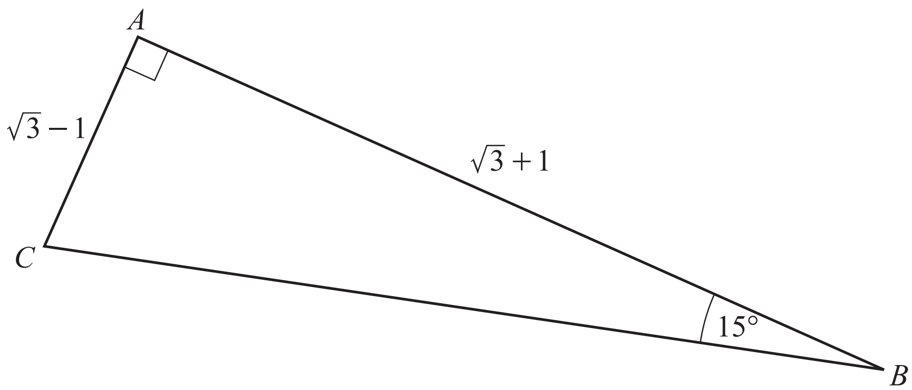
(a) Find $\frac{dy}{dx}$. [3]

(b) Find the value of x for which $\frac{dy}{dx} = -\frac{1}{2}$. [3]

5 The first three terms in the expansion of $(a+bx)^5(1+x)$ are $32-208x+cx^2$. Find the value of each of the integers a, b and c. [7]

6 DO NOT USE A CALCULATOR IN THIS QUESTION.

In this question all lengths are in centimetres.



In the diagram above $AC = \sqrt{3}-1$, $AB = \sqrt{3}+1$, angle $ABC = 15°$ and angle $CAB = 90°$.

(a) Show that $\tan 15° = 2-\sqrt{3}$. [3]

(b) Find the exact length of BC. [2]

7 DO NOT USE A CALCULATOR IN THIS QUESTION.

$$p(x) = 2x^3 - 3x^2 - 23x + 12$$

(a) Find the value of $p\left(\frac{1}{2}\right)$. [1]

(b) Write $p(x)$ as the product of three linear factors and hence solve $p(x) = 0$. [5]

8 The population P, in millions, of a country is given by $P = A \times b^t$, where t is the number of years after January 2000 and A and b are constants. In January 2010 the population was 40 million and had increased to 45 million by January 2013.

(a) Show that $b = 1.04$ to 2 decimal places and find A to the nearest integer. [4]

(b) Find the population in January 2020, giving your answer to the nearest million. [1]

(c) In January of which year will the population be over 100 million for the first time? [3]

9 A particle moves in a straight line such that, t seconds after passing a fixed point O, its displacement from O is s m, where $s = e^{2t} - 10e^{t} - 12t + 9$.

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

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

(c) Find the acceleration at this time. [2]

10 The gradient of the normal to a curve at the point (x, y) is given by $\dfrac{x}{x+1}$.

(a) Given that the curve passes through the point (1, 4), show that its equation is $y = 5 - \ln x - x$. [5]

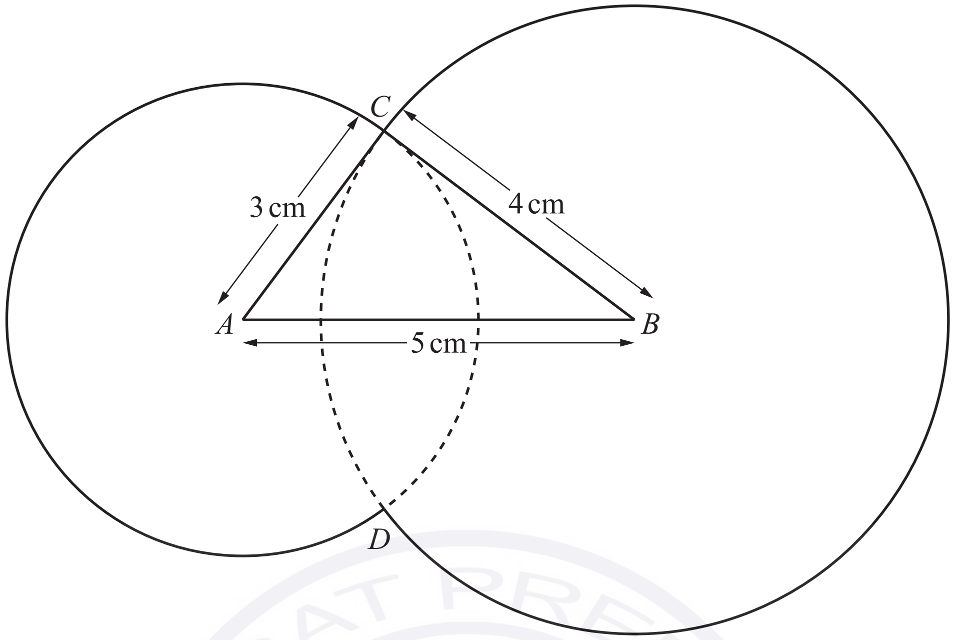
(b) Find, in the form $y = mx + c$, the equation of the tangent to the curve at the point where $x = 3$. [3]

11 The equation of a curve is $y = x\sqrt{16 - x^2}$ for $0 \leqslant x \leqslant 4$.

(a) Find the exact coordinates of the stationary point of the curve. [6]

(b) Find $\frac{\mathrm{d}}{\mathrm{d}x}\left(16-x^2\right)^{\frac{3}{2}}$ and hence evaluate the area enclosed by the curve $y = x\sqrt{16-x^2}$ and the lines $y = 0$, $x = 1$ and $x = 3$. [5]

12



The diagram shows a shape consisting of two circles of radius 3 cm and 4 cm with centres A and B which are 5 cm apart. The circles intersect at C and D as shown. The lines AC and BC are tangents to the circles, centres B and A respectively. Find

(a) the angle CAB in radians, [2]

(b) the perimeter of the whole shape, [4]

(c) the area of the whole shape. [4]

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CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

6696758013

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **October/November 2020**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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INFORMATION

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- The number of marks for each question or part question is shown in brackets [ ].

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Mathematical Formulae

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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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

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Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

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

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

1 Solve the inequality $(x-8)(x-10) > 35$. [4]

2 Find the value of x such that $\dfrac{4^{x+1}}{2^{x-1}} = 32^{\frac{x}{3}} \times 8^{\frac{1}{3}}$. [4]

3 **(a)** Find the equation of the perpendicular bisector of the line joining the points (12, 1) and (4, 3), giving your answer in the form $y = mx + c$. [5]

(b) The perpendicular bisector cuts the axes at points A and B. Find the length of AB. [3]

4 Solve the simultaneous equations.

$$\log_3(x+y) = 2$$
$$2\log_3(x+1) = \log_3(y+2)$$

[6]

5 DO NOT USE A CALCULATOR IN THIS QUESTION.

(a) Find the equation of the tangent to the curve $y = x^3 - 6x^2 + 3x + 10$ at the point where $x = 1$. [4]

(b) Find the coordinates of the point where this tangent meets the curve again. [5]

6 Find the exact value of $\int_2^4 \frac{(x+1)^2}{x^2}\,\mathrm{d}x$. [6]

7 A geometric progression has a first term of 3 and a second term of 2.4. For this progression, find

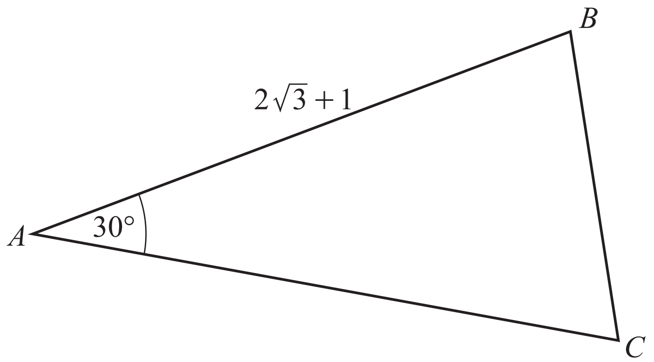
(a) the sum of the first 8 terms, [3]

(b) the sum to infinity, [1]

(c) the least number of terms for which the sum is greater than 95% of the sum to infinity. [4]

8 DO NOT USE A CALCULATOR IN THIS QUESTION.

In this question lengths are in centimetres.



You may use the following trigonometric ratios.

$\sin 30° = \frac{1}{2}$

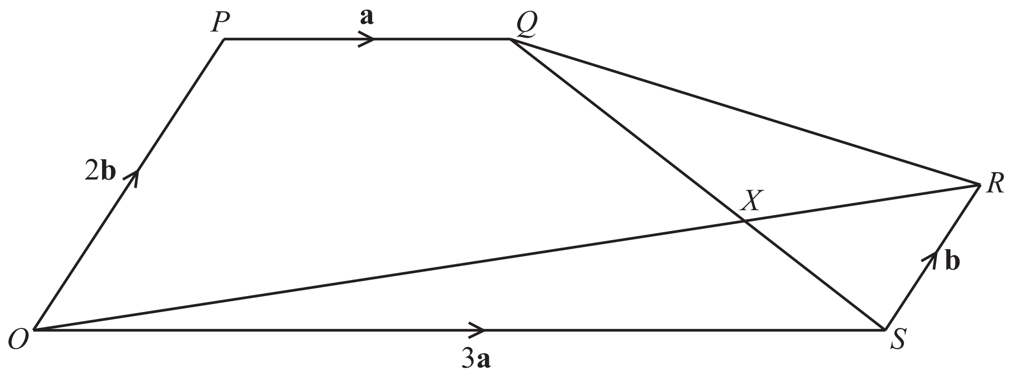
$\cos 30° = \frac{\sqrt{3}}{2}$

$\tan 30° = \frac{1}{\sqrt{3}}$

(a) Given that the area of the triangle ABC is $5.5\,\text{cm}^2$, find the exact length of AC. Write your answer in the form $a+b\sqrt{3}$, where a and b are integers. [4]

(b) Show that $BC^2 = c+d\sqrt{3}$, where c and d are integers to be found. [4]

9



In the diagram $\overrightarrow{OP} = 2\mathbf{b}$, $\overrightarrow{OS} = 3\mathbf{a}$, $\overrightarrow{SR} = \mathbf{b}$ and $\overrightarrow{PQ} = \mathbf{a}$. The lines OR and QS intersect at X.

(a) Find $\overrightarrow{OQ}$ in terms of **a** and **b**. [1]

(b) Find $\overrightarrow{QS}$ in terms of **a** and **b**. [1]

(c) Given that $\overrightarrow{QX} = \mu\overrightarrow{QS}$, find $\overrightarrow{OX}$ in terms of **a**, **b** and μ. [1]

(d) Given that $\overrightarrow{OX} = \lambda\overrightarrow{OR}$, find $\overrightarrow{OX}$ in terms of **a**, **b** and λ. [1]

(e) Find the value of λ and of μ. [3]

(f) Find the value of $\frac{QX}{XS}$. [1]

(g) Find the value of $\frac{OR}{OX}$. [1]

10 The number, b, of bacteria in a sample is given by $b = P + Qe^{2t}$, where P and Q are constants and t is time in weeks. Initially there are 500 bacteria which increase to 600 after 1 week.

(a) Find the value of P and of Q. [4]

(b) Find the number of bacteria present after 2 weeks. [1]

(c) Find the first week in which the number of bacteria is greater than 1 000 000. [3]

11 **(a)** Show that $\dfrac{\sin x \tan x}{1 - \cos x} = 1 + \sec x$. [4]

(b) Solve the equation $5\tan x - 3\cot x = 2\sec x$ for $0° \leqslant x \leqslant 360°$. [6]

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Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4908419373

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2020**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Blank pages are indicated.

DC (LK/SG) 187992/4

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 $\binom{n}{r} = \frac{n!}{(n-r)!\,r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 Solve $|3x-2| = 4+x$. [3]

2 Solve the simultaneous equations.

$$x^2 + 3xy = 4$$
$$2x + 5y = 4$$

[5]

3 Find the values of k for which the equation $x^2 + (k+9)x + 9 = 0$ has two distinct real roots. [4]

4 It is given that $y = \ln(1 + \sin x)$ for $0 < x < \pi$.

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

(b) Find the value of $\frac{dy}{dx}$ when $x = \frac{\pi}{6}$, giving your answer in the form $\frac{1}{\sqrt{a}}$, where a is an integer. [2]

(c) Find the values of x for which $\frac{dy}{dx} = \tan x$. [5]

5 Solve the following simultaneous equations.

$$3^x \times 9^{y-1} = 243$$

$$8 \times 2^{y-\frac{1}{2}} = \frac{2^{2x+1}}{4\sqrt{2}}$$

[5]

6 A 4-digit code is to be formed using 4 different numbers selected from 1, 2, 3, 4, 5, 6, 7, 8 and 9. Find how many different codes can be formed if

(a) there are no restrictions, [1]

(b) only prime numbers are used, [1]

(c) two even numbers are followed by two odd numbers, [2]

(d) the code forms an even number. [2]

7 A curve has equation $y = x\cos x$.

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

(b) Find the equation of the normal to the curve at the point where $x = \pi$, giving your answer in the form $y = mx + c$. [4]

(c) Using your answer to **part (a)**, find the exact value of $\int_0^{\frac{\pi}{6}} x\sin x \, dx$. [5]

8 DO NOT USE A CALCULATOR IN THIS QUESTION.

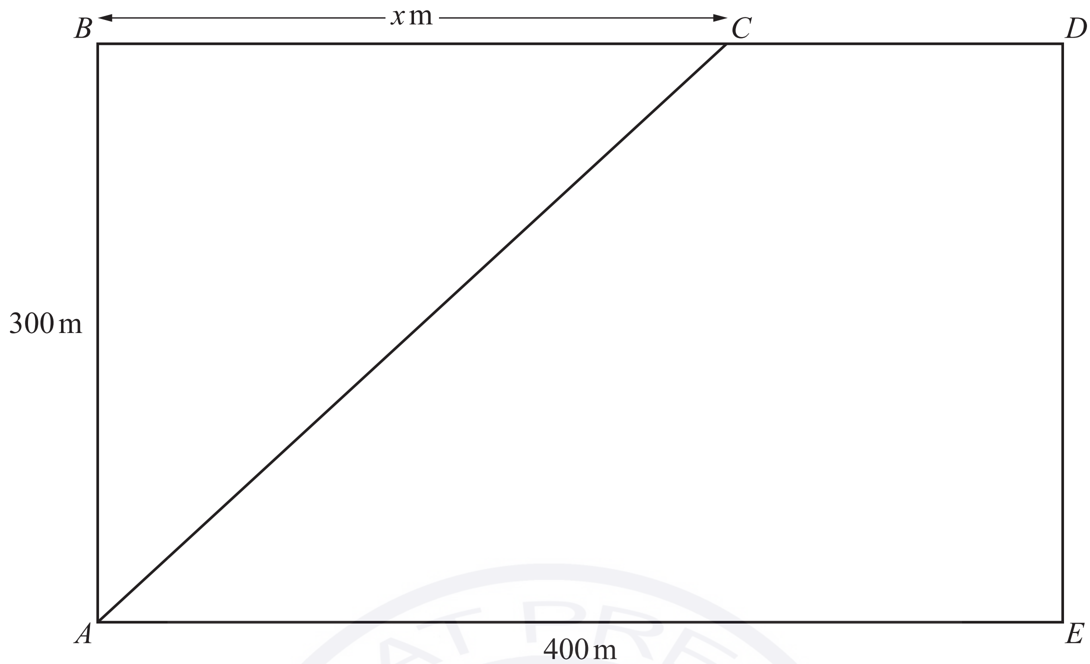
$$\log_2(y+1) = 3 - 2\log_2 x$$
$$\log_2(x+2) = 2 + \log_2 y$$

(a) Show that $x^3 + 6x^2 - 32 = 0$. [4]

(b) Find the roots of $x^3 + 6x^2 - 32 = 0$. [4]

(c) Give a reason why only one root is a valid solution of the logarithmic equations. Find the value of y corresponding to this root. [2]

9



The rectangle $ABCDE$ represents a ploughed field where $AB = 300\,\text{m}$ and $AE = 400\,\text{m}$. Joseph needs to walk from A to D in the least possible time. He can walk at $0.9\,\text{ms}^{-1}$ on the ploughed field and at $1.5\,\text{ms}^{-1}$ on any part of the path BCD along the edge of the field. He walks from A to C and then from C to D. The distance $BC = x\,\text{m}$.

(a) Find, in terms of x, the total time, T s, Joseph takes for the journey. [3]

(b) Given that x can vary, find the value of x for which T is a minimum and hence find the minimum value of T. [6]

10 **(a)** The sum of the first 4 terms of an arithmetic progression is 38 and the sum of the next 4 terms is 86. Find the first term and the common difference. [5]

(b) The third term of a geometric progression is 12 and the sixth term is -96. Find the sum of the first 10 terms of this progression. [6]

Question 11 is printed on the next page.

11 DO NOT USE A CALCULATOR IN THIS QUESTION.

Solve the quadratic equation $\left(\sqrt{7}-2\right)x^2-4x+\left(\sqrt{7}+2\right)=0$, giving each of your answers in the form $a+b\sqrt{7}$, where a and b are constants. [7]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3574984631

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2020**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
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- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

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- The number of marks for each question or part question is shown in brackets [ ].

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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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

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

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 Variables x and y are such that, when $\sqrt[4]{y}$ is plotted against $\frac{1}{x}$, a straight line graph passing through the points (0.5, 9) and (3, 34) is obtained. Find y as a function of x. [4]

2 **(a)** Write $9x^2 - 12x + 5$ in the form $p(x-q)^2 + r$, where p, q and r are constants. [3]

(b) Hence write down the coordinates of the minimum point of the curve $y = 9x^2 - 12x + 5$. [1]

3 DO NOT USE A CALCULATOR IN THIS QUESTION.

$$p(x) = 15x^3 + 22x^2 - 15x + 2$$

(a) Find the remainder when $p(x)$ is divided by $x + 1$. [2]

(b) **(i)** Show that $x + 2$ is a factor of $p(x)$. [1]

(ii) Write $p(x)$ as a product of linear factors. [3]

4 **(a)** In an examination, candidates must select 2 questions from the 5 questions in section A and select 4 questions from the 8 questions in section B. Find the number of ways in which this can be done. [2]

(b) The digits of the number 6 378 129 are to be arranged so that the resulting 7-digit number is even. Find the number of ways in which this can be done. [2]

5 The vectors **a** and **b** are such that $\mathbf{a} = \alpha\mathbf{i} + \mathbf{j}$ and $\mathbf{b} = 12\mathbf{i} + \beta\mathbf{j}$.

(a) Find the value of each of the constants α and β such that $4\mathbf{a} - \mathbf{b} = (\alpha + 3)\mathbf{i} - 2\mathbf{j}$. [3]

(b) Hence find the unit vector in the direction of $\mathbf{b} - 4\mathbf{a}$. [2]

6 Find the values of k for which the line $y = kx - 7$ and the curve $y = 3x^2 + 8x + 5$ do not intersect. [6]

7 **(a)** Solve the simultaneous equations

$$10^{x+2y} = 5,$$
$$10^{3x+4y} = 50,$$

giving x and y in exact simplified form. [4]

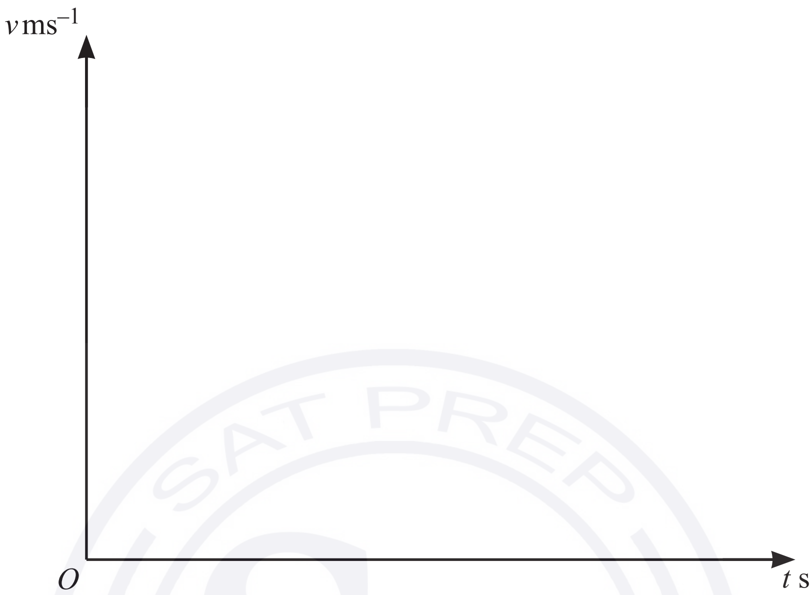
(b) Solve $2x^{\frac{2}{3}} - x^{\frac{1}{3}} - 10 = 0.$ [3]

8 **(a)** Expand $(2-x)^5$, simplifying each coefficient. [3]

(b) Hence solve $\frac{e^{(2-x)^5} \times e^{80x}}{e^{10x^4+32}} = e^{-x^5}$. [4]

9 A particle travels in a straight line. As it passes through a fixed point O, the particle is travelling at a velocity of $3\,\text{ms}^{-1}$. The particle continues at this velocity for 60 seconds then decelerates at a constant rate for 15 seconds to a velocity of $1.6\,\text{ms}^{-1}$. The particle then decelerates again at a constant rate for 5 seconds to reach point A, where it stops.

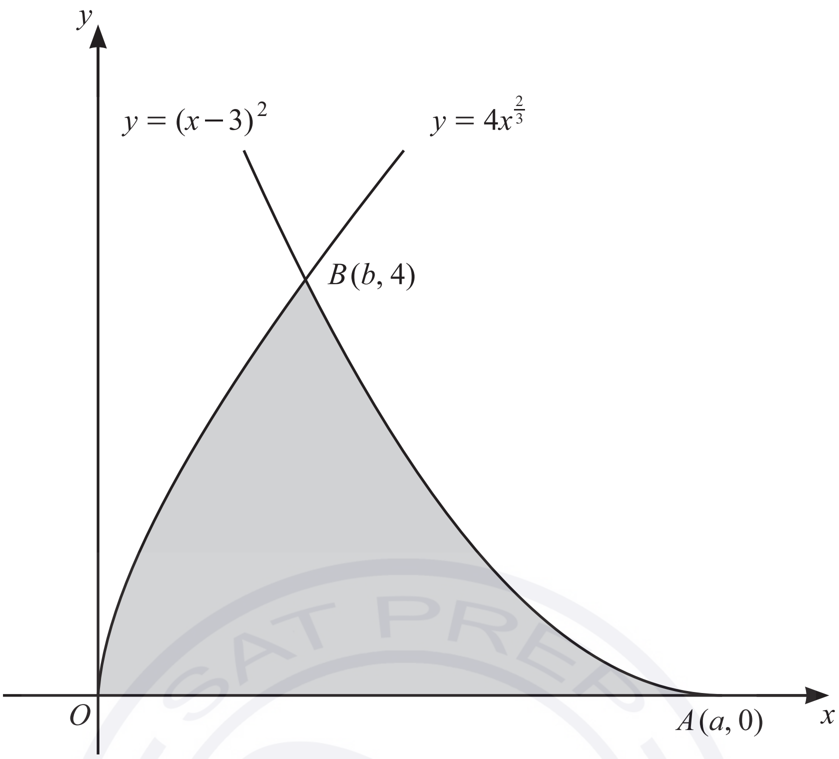
(a) Sketch the velocity-time graph for this journey on the axes below. [3]



(b) Find the distance between O and A. [3]

(c) Find the deceleration in the last 5 seconds. [1]

10



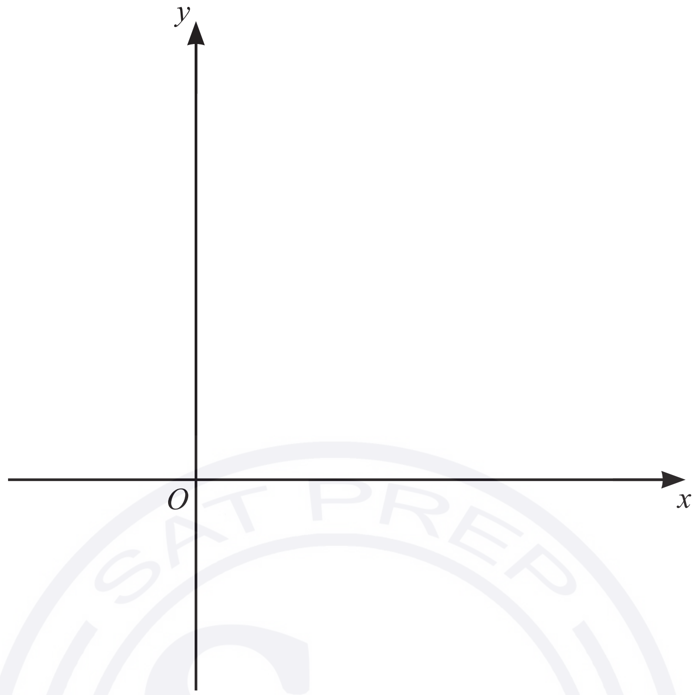
The diagram shows part of the graphs of $y = 4x^{\frac{2}{3}}$ and $y = (x-3)^2$. The graph of $y = (x-3)^2$ meets the x-axis at the point $A(a, 0)$ and the two graphs intersect at the point $B(b, 4)$.

(a) Find the value of a and of b. [2]

(b) Find the area of the shaded region. [5]

11 The function f is defined by $\mathrm{f}(x) = \ln(2x+1)$ for $x \geqslant 0$.

(a) Sketch the graph of $y = \mathrm{f}(x)$ and hence sketch the graph of $y = \mathrm{f}^{-1}(x)$ on the axes below. [3]



The function g is defined by $\mathrm{g}(x) = (x-4)^2 + 1$ for $x \leqslant 4$.

(b) **(i)** Find an expression for $\mathrm{g}^{-1}(x)$ and state its domain and range. [4]

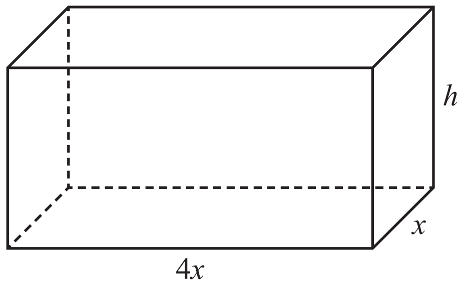
(ii) Find and simplify an expression for $\mathrm{fg}(x)$. [2]

(iii) Explain why the function gf does not exist. [1]

12 **(a)** Find the x-coordinates of the stationary points of the curve $y = e^{3x}(2x+3)^6$. [6]

(b) A curve has equation $y = f(x)$ and has exactly two stationary points. Given that $f''(x) = 4x - 7$, $f'(0.5) = 0$ and $f'(3) = 0$, use the second derivative test to determine the nature of each of the stationary points of this curve. [2]

(c) In this question all lengths are in centimetres.



The diagram shows a solid cuboid with height h and a rectangular base measuring $4x$ by x. The volume of the cuboid is $40\,\text{cm}^3$. Given that x and h can vary and that the surface area of the cuboid has a minimum value, find this value. [5]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0698096858

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2020**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
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- Do **not** write on any bar codes.
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- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Blank pages are indicated.

DC (PQ/CB) 183938/6

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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 Variables x and y are such that $y = \sin x + e^{-x}$. Use differentiation to find the approximate change in y as x increases from $\frac{\pi}{4}$ to $\frac{\pi}{4} + h$, where h is small. [4]

2 **DO NOT USE A CALCULATOR IN THIS QUESTION.**

The point $\left(1 - \sqrt{5}, p\right)$ lies on the curve $y = \frac{10 + 2\sqrt{5}}{x^2}$. Find the exact value of p, simplifying your answer. [5]

3 Find the values of k for which the line $y = x - 3$ intersects the curve $y = k^2x^2 + 5kx + 1$ at two distinct points. [6]

4 The three roots of $\mathrm{p}(x) = 0$, where $\mathrm{p}(x) = 2x^3 + ax^2 + bx + c$ are $x = \frac{1}{2}$, $x = n$ and $x = -n$, where a, b, c and n are integers. The y-intercept of the graph of $y = \mathrm{p}(x)$ is 4. Find $\mathrm{p}(x)$, simplifying your coefficients. [5]

5 Solutions to this question by accurate drawing will not be accepted.

The points A and B are (4, 3) and (12, −7) respectively.

(a) Find the equation of the line L, the perpendicular bisector of the line AB. [4]

(b) The line parallel to AB which passes through the point (5, 12) intersects L at the point C. Find the coordinates of C. [4]

6 **(a)** Find the equation of the tangent to the curve $2y = \tan 2x + 7$ at the point where $x = \frac{\pi}{8}$.

Give your answer in the form $ax - y = \frac{\pi}{b} + c$, where a, b and c are integers. [5]

(b) This tangent intersects the x-axis at P and the y-axis at Q. Find the length of PQ. [2]

7 Giving your answer in its simplest form, find the exact value of

(a) $\int_0^4 \frac{10}{5x+2}\,dx$, [4]

(b) $\int_0^{\ln 2} \left(e^{4x+2}\right)^2 dx$. [5]

8 **(a)** Solve $3\cot^2 x - 14\operatorname{cosec} x - 2 = 0$ for $0° < x < 360°$. [5]

(b) Show that $\dfrac{\sin^4 y - \cos^4 y}{\cot y} = \tan y - 2\cos y \sin y$. [4]

9 **(a)** Solve the equation $\dfrac{9^{5x}}{27^{x-2}} = 243$. [3]

(b) $\log_a \sqrt{b} - \dfrac{1}{2} = \log_b a$, where $a > 0$ and $b > 0$.

Solve this equation for b, giving your answers in terms of a. [5]

10 **(a)** The first 5 terms of a sequence are given below.

$$4 \qquad -2 \qquad 1 \qquad -0.5 \qquad 0.25$$

(i) Find the 20th term of the sequence. [2]

(ii) Explain why the sum to infinity exists for this sequence and find the value of this sum. [2]

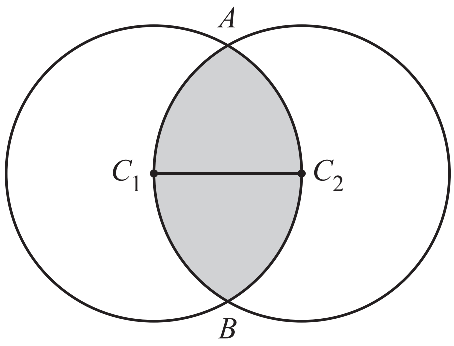
(b) The tenth term of an arithmetic progression is 15 times the second term. The sum of the first 6 terms of the progression is 87.

(i) Find the common difference of the progression. [4]

(ii) For this progression, the *n*th term is 6990. Find the value of *n*. [3]

Question 11 is printed on the next page.

11



The circles with centres C_1 and C_2 have equal radii of length r cm. The line C_1C_2 is a radius of both circles. The two circles intersect at A and B.

(a) Given that the perimeter of the shaded region is 4π cm, find the value of r. [4]

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

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5963414462

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2020**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

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DC (PQ/CB) 183935/5

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

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

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

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

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

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$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

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

Formulae for ΔABC

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

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

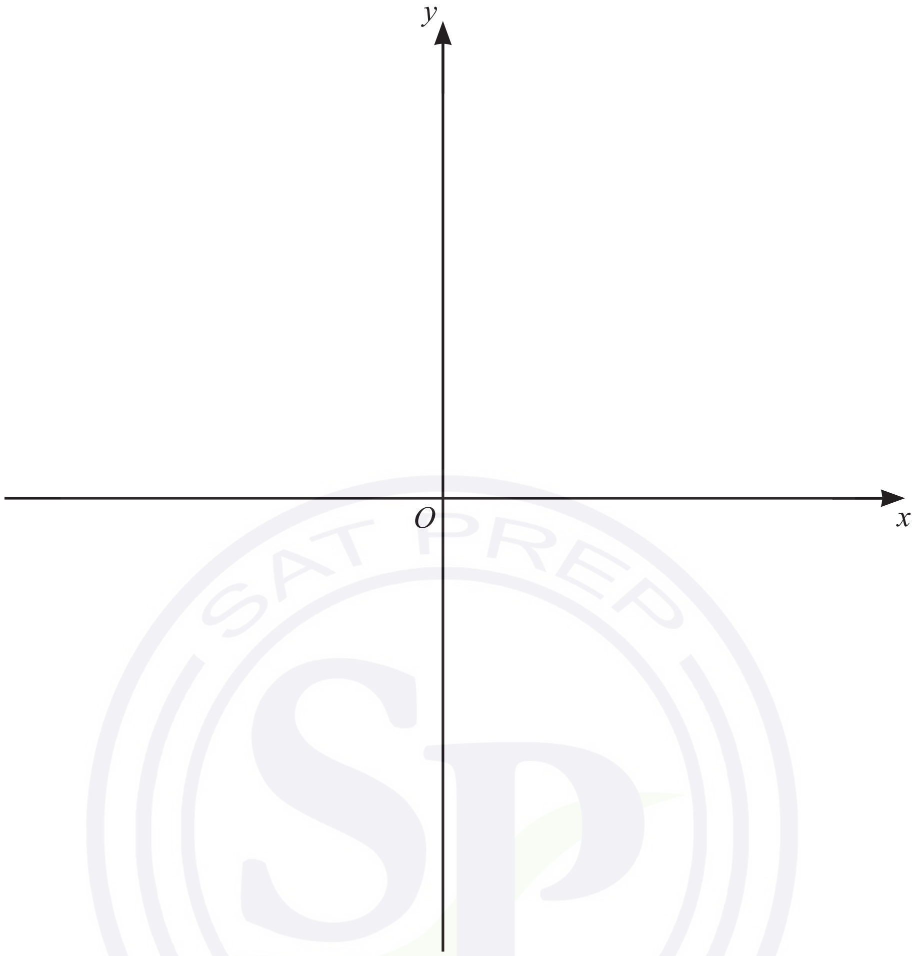
$$\Delta = \frac{1}{2}bc\sin A$$

1 **Solutions to this question by accurate drawing will not be accepted.**

Find the equation of the perpendicular bisector of the line joining the points $(4, -7)$ and $(-8, 9)$. [4]

2 Find the set of values of k for which $4x^2 - 4kx + 2k + 3 = 0$ has no real roots. [5]

3 **(a)** On the axes below, sketch the graph of $y = -(x+2)(x-1)(x-6)$, showing the coordinates of the points where the graph meets the coordinate axes.



[2]

(b) Hence solve $-(x+2)(x-1)(x-6) \leqslant 0$. [2]

4 **(a)** **(i)** Find how many different 5-digit numbers can be formed using five of the eight digits 1, 2, 3, 4, 5, 6, 7, 8 if each digit can be used once only. [2]

(ii) Find how many of these 5-digit numbers are greater than 60 000. [2]

(b) A team of 3 people is to be selected from 4 men and 5 women. Find the number of different teams that could be selected which include at least 2 women. [2]

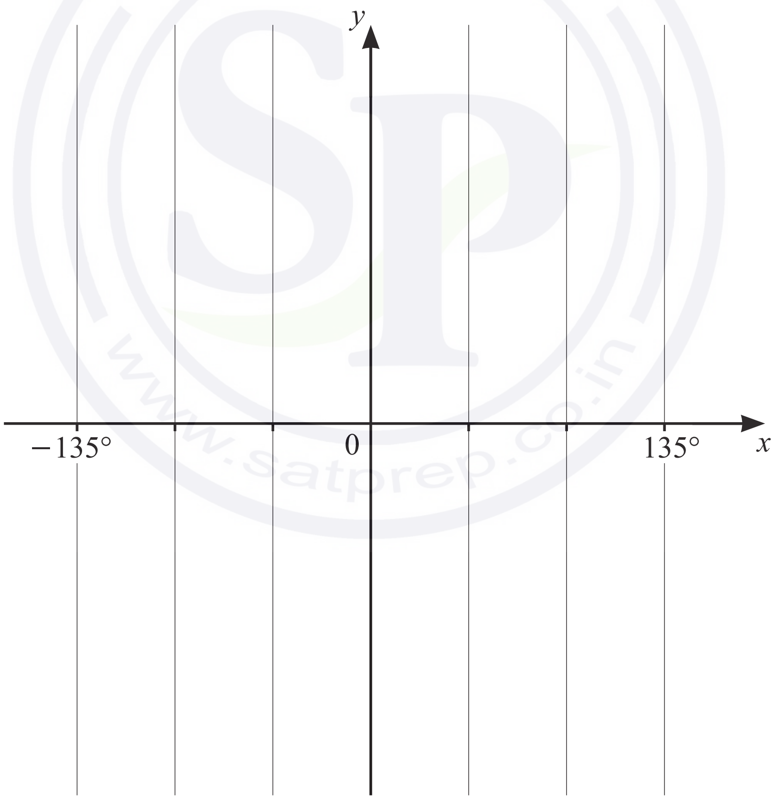
5 DO NOT USE A CALCULATOR IN THIS QUESTION.

(a) Simplify $\frac{\sqrt{128}}{\sqrt{72}}$. [2]

(b) Simplify $\frac{1}{1+\sqrt{3}} - \frac{\sqrt{3}}{3+2\sqrt{3}}$, giving your answer as a fraction with an integer denominator. [4]

6 **(a)** The curve $y = a\sin bx + c$ has a period of 180°, an amplitude of 20 and passes through the point (90°, −3). Find the value of each of the constants a, b and c. [3]

(b) The function g is defined, for $-135° \leqslant x \leqslant 135°$, by $g(x) = 3\tan\frac{x}{2} - 4$. Sketch the graph of $y = g(x)$ on the axes below, stating the coordinates of the point where the graph crosses the y-axis. [2]



7 Variables x and y are connected by the relationship $y = Ax^n$, where A and n are constants.

(a) Transform the relationship $y = Ax^n$ to straight line form. [2]

When $\ln y$ is plotted against $\ln x$ a straight line graph passing through the points (0, 0.5) and (3.2, 1.7) is obtained.

(b) Find the value of n and of A. [4]

(c) Find the value of y when $x = 11$. [2]

8 **(a)** Differentiate $y = \tan(x+4) - 3\sin x$ with respect to x. [2]

(b) Variables x and y are such that $y = \frac{\ln(2x+5)}{2e^{3x}}$. Use differentiation to find the approximate change in y as x increases from 1 to $1 + h$, where h is small. [6]

9 DO NOT USE A CALCULATOR IN THIS QUESTION.

(a) Find the term independent of x in the binomial expansion of $\left(3x - \frac{1}{x}\right)^6$. [2]

(b) In the expansion of $\left(1 + \frac{x}{2}\right)^n$ the coefficient of x^4 is half the coefficient of x^6. Find the value of the positive constant n. [6]

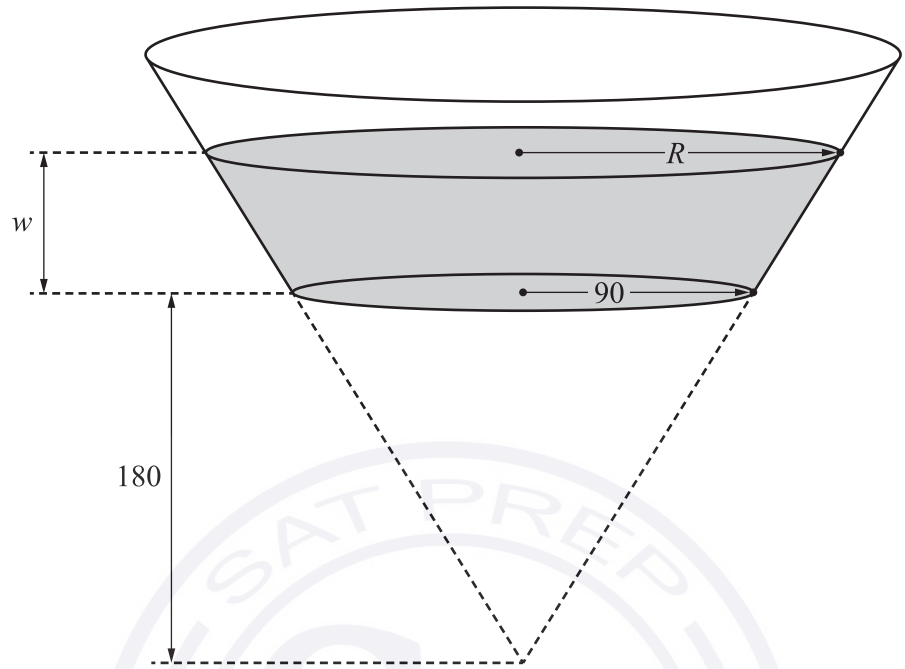
10 Solve the equation

(a) $5\sec^2 A + 14\tan A - 8 = 0$ for $0° \leqslant A \leqslant 180°$, [4]

(b) $5\sin\left(4B - \frac{\pi}{8}\right) + 2 = 0$ for $-\frac{\pi}{4} \leqslant B \leqslant \frac{\pi}{4}$ radians. [4]

11 In this question all lengths are in centimetres.

The volume, V, of a cone of height h and base radius r is given by $V = \frac{1}{3}\pi r^2 h$.



The diagram shows a large hollow cone from which a smaller cone of height 180 and base radius 90 has been removed. The remainder has been fitted with a circular base of radius 90 to form a container for water. The depth of water in the container is w and the surface of the water is a circle of radius R.

(a) Find an expression for R in terms of w and show that the volume V of the water in the container is given by $V = \frac{\pi}{12}(w+180)^3 - 486000\pi$. [3]

(b) Water is poured into the container at a rate of $10\,000\ \text{cm}^3\text{s}^{-1}$. Find the rate at which the depth of the water is increasing when $w = 10$. [4]

12 **(a)** **(i)** Given that $f(x) = \dfrac{1}{\cos x}$, show that $f'(x) = \tan x \sec x$. [3]

(ii) Hence find $\int \left(3\tan x \sec x - \sqrt[4]{e^{3x}}\right) dx$. [3]

(b) Given that $\int_{2}^{5} \frac{p}{px+10}\,dx = \ln 2$, find the value of the positive constant p. [5]

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Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1552216622

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **February/March 2020**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Blank pages are indicated.

DC (PQ/CB) 196734/3 **R**

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

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

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

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

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

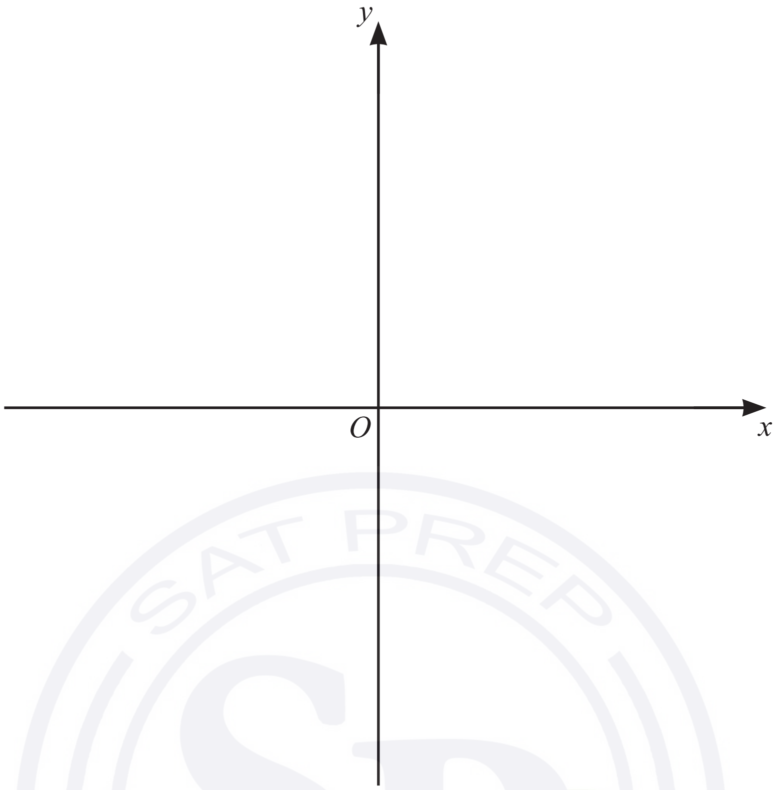
1 Find the values of x for which $12x^2 - 20x + 5 < (2x+1)(x-1)$. [4]

2 Variables x and y are such that, when $\lg y$ is plotted against x^3, a straight line graph passing through the points (6, 7) and (10, 9) is obtained. Find y as a function of x. [4]

3 Find the exact solution of $3^{2x} - 3^{x+1} - 4 = 0$. [4]

4 The position vectors of three points, A, B and C, relative to an origin O, are $\begin{pmatrix} -5 \\ -7 \end{pmatrix}$, $\begin{pmatrix} 10 \\ -4 \end{pmatrix}$ and $\begin{pmatrix} x \\ y \end{pmatrix}$ respectively. Given that $\overrightarrow{AC} = 4\overrightarrow{BC}$, find the unit vector in the direction of $\overrightarrow{OC}$. [5]

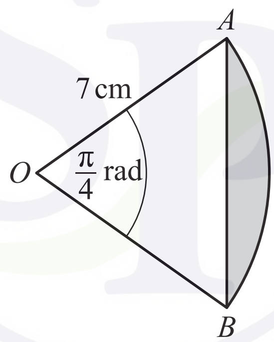
5 **(a)** On the axes below, sketch the graph of $y = |5x - 7|$, showing the coordinates of the points where the graph meets the coordinate axes. [3]



(b) Solve $5|5x - 7| - 1 = 14$. [3]

6 **(a)** A circle has a radius of 6 cm. A sector of this circle has a perimeter of $2(6+5\pi)$ cm. Find the area of this sector. [4]

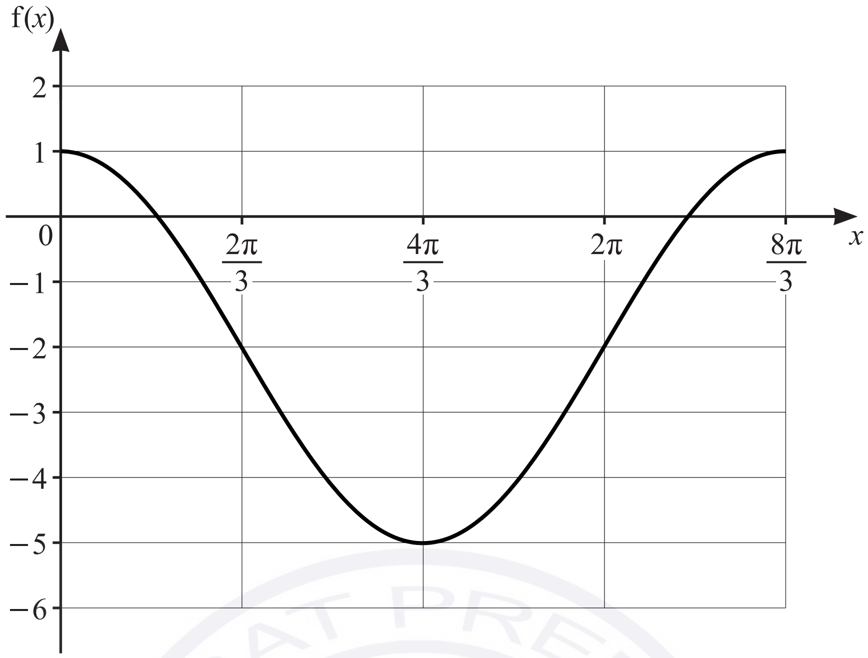
(b)



The diagram shows the sector *AOB* of a circle with centre *O* and radius 7 cm.
Angle $AOB = \frac{\pi}{4}$ radians. Find the perimeter of the shaded region. [3]

7 Find the coordinates of the points of intersection of the curves $x^2 = 5y - 1$ and $y = x^2 - 2x + 1$. [5]

8



The diagram shows the graph of $f(x) = a\cos bx + c$ for $0 \leqslant x \leqslant \frac{8\pi}{3}$ radians.

(a) Explain why f is a function. [1]

(b) Write down the range of f. [1]

(c) Find the value of each of the constants a, b and c. [4]

9 Variables x and y are such that $y = \frac{e^{3x}\sin x}{x^2}$. Use differentiation to find the approximate change in y as x increases from 0.5 to $0.5 + h$, where h is small. [6]

10 **(a)** $\mathrm{g}(x) = 3 + \frac{1}{x}$ for $x \geqslant 1$.

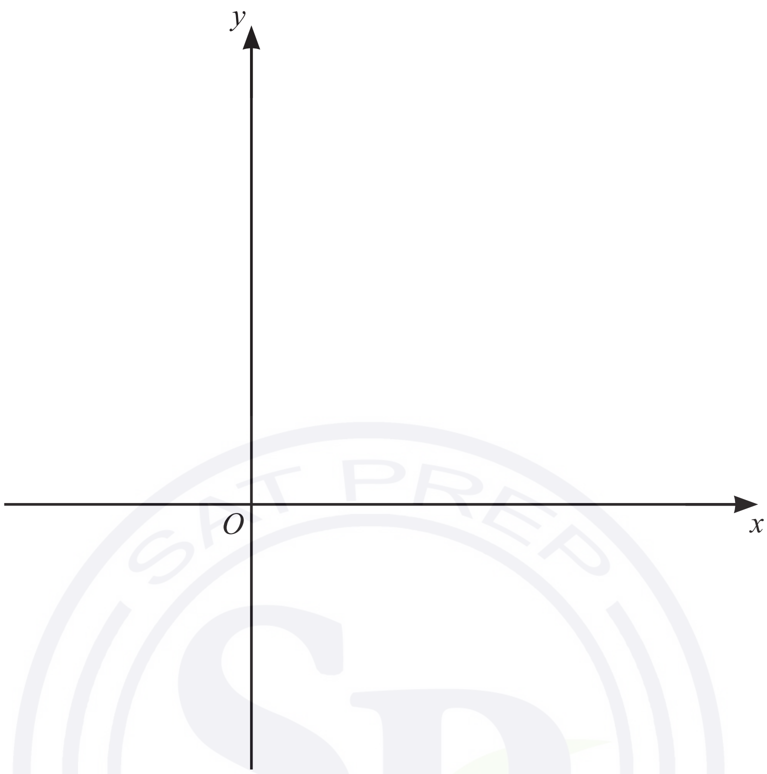
(i) Find an expression for $\mathrm{g}^{-1}(x)$. [2]

(ii) Write down the range of g^{-1}. [1]

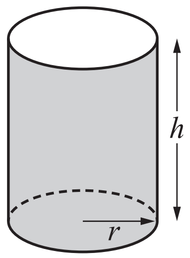
(iii) Find the domain of g^{-1}. [2]

(b) $\mathrm{h}(x) = 2\ln(3x - 1)$ for $x \geqslant \frac{2}{3}$.

The graph of $y = \mathrm{h}(x)$ intersects the line $y = x$ at two distinct points. On the axes below, sketch the graph of $y = \mathrm{h}(x)$ and hence sketch the graph of $y = \mathrm{h}^{-1}(x)$. [4]



11



A container is a circular cylinder, open at one end, with a base radius of r cm and a height of h cm. The volume of the container is $1000\,\text{cm}^3$. Given that r and h can vary and that the total outer surface area of the container has a minimum value, find this value. [8]

12 A particle P moves in a straight line such that, t seconds after passing through a fixed point O, its acceleration, a ms^{-2}, is given by $a = -6$. When $t = 0$, the velocity of P is $18\,\text{ms}^{-1}$.

(a) Find the time at which P comes to instantaneous rest. [3]

(b) Find the distance travelled by P in the 3rd second. [3]

13 **(a)** The sum of the first two terms of a geometric progression is 10 and the third term is 9.

(i) Find the possible values of the common ratio and the first term. [5]

(ii) Find the sum to infinity of the convergent progression. [1]

(b) In an arithmetic progression, $u_1 = -10$ and $u_4 = 14$. Find $u_{100} + u_{101} + u_{102} + \ldots + u_{200}$, the sum of the 100th to the 200th terms of the progression. [4]

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Cambridge IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **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 **15** printed pages and **1** blank page.

DC (NF/SG) 172320/3

Cambridge Assessment International Education

[Turn over

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

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

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

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

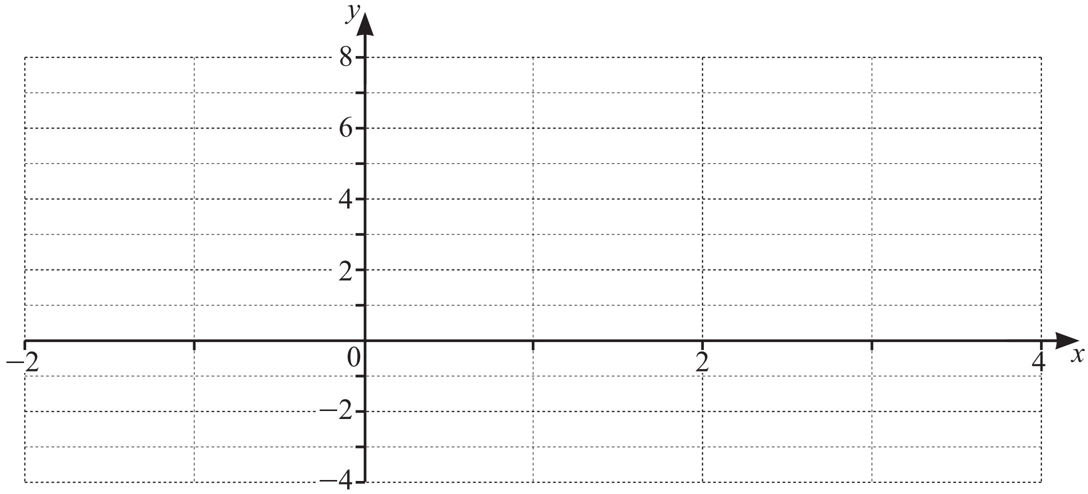
Formulae for ΔABC

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

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

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

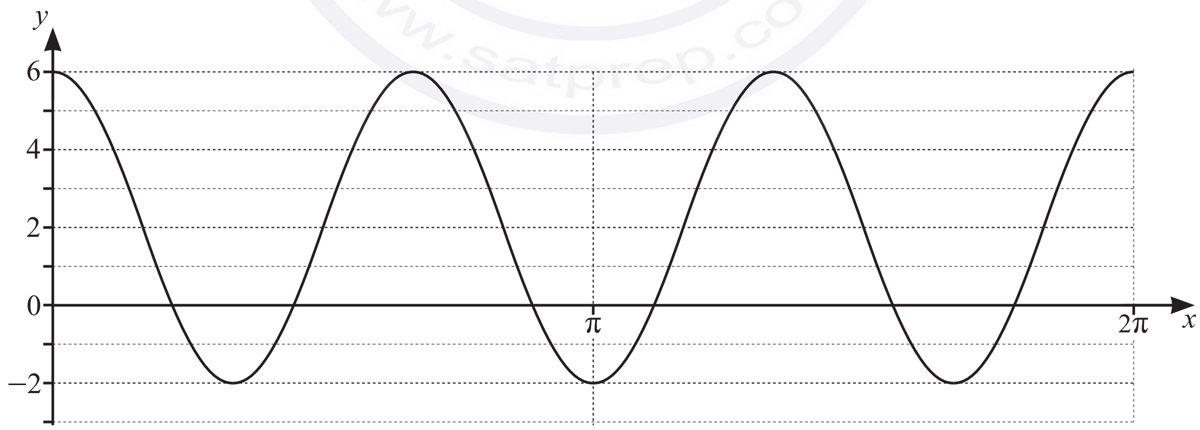
1 **(i)** On the axes below, draw the graph of $y = |2x - 3|$.



[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]

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]

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]

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]

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

(i) Find $\frac{\mathrm{d}y}{\mathrm{d}x}$. [3]

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

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 **D**, where $\mathbf{B}^{-2}\mathbf{DA} = \mathbf{I}$. [3]

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 $300\,\text{km}\,\text{h}^{-1}$ 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 $280\,\text{km}\,\text{h}^{-1}$.

(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 IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5192885901

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **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.
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DO **NOT** WRITE IN ANY BARCODES.

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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.
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The total number of marks for this paper is 80.

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

DC (LEG/SG) 172298/2

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

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

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

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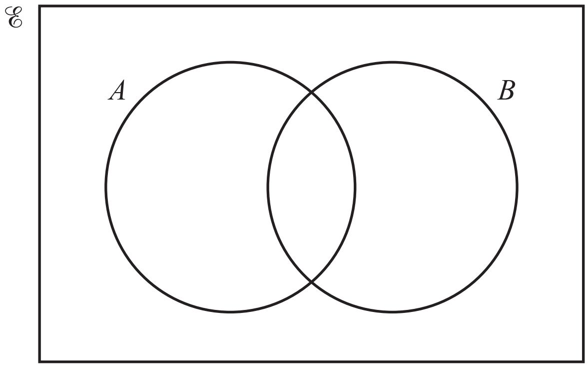
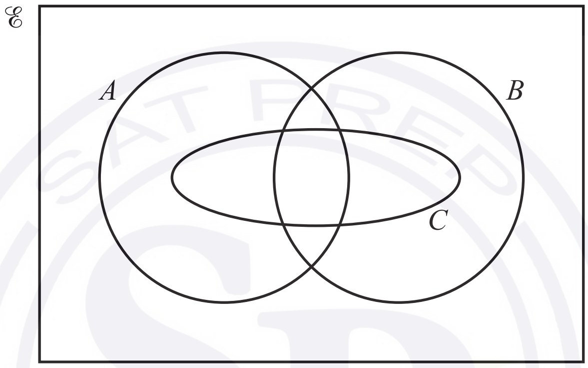
$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

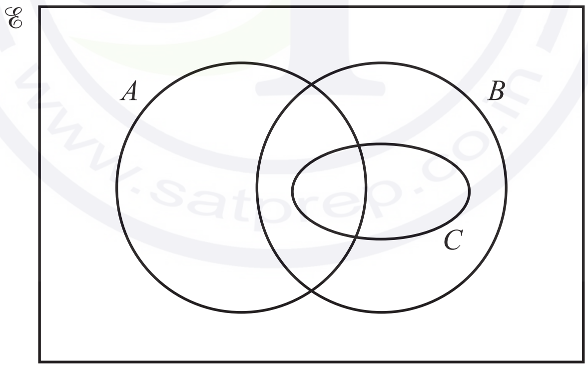
1 On each of the Venn diagrams below, shade the region indicated.



$(A' \cap B) \cup (A \cap B')$



$(A \cap B) \cup C$



$A \cap B \cap C'$

[3]

2 Given that $y = 2\sin 3x + \cos 3x$, show that $\frac{d^2y}{dx^2} + \frac{dy}{dx} + 3y = k\sin 3x$, where k is a constant to be determined. [5]

3 A 5-digit code is formed using the following characters.

Letters	a e i o u
Numbers	1 2 3 4 5 6
Symbols	@ * #

No character can be repeated in a code. Find the number of possible codes if

(i) there are no restrictions, [2]

(ii) the code starts with a symbol followed by two letters and then two numbers, [2]

(iii) the first two characters are numbers, and no other numbers appear in the code. [2]

4 Find the values of k for which the line $y = kx + 3$ does not meet the curve $y = x^2 + 5x + 12$. [5]

5 At the point where $x = 1$ on the curve $y = \frac{k}{(x+1)^2}$, the normal has a gradient of $\frac{1}{3}$.

(i) Find the value of the constant k. [4]

(ii) Using your value of k, find the equation of the tangent to the curve at $x = 2$. [3]

6 **(i)** Show that $\frac{\tan x}{1+\sec x}+\frac{1+\sec x}{\tan x}=\frac{2}{\sin x}$. [5]

(ii) Hence solve the equation $\frac{\tan x}{1+\sec x}+\frac{1+\sec x}{\tan x}=1+3\sin x$ for $0° \leqslant x \leqslant 180°$. [4]

7 **(a)** The cubic equation $x^3 + ax^2 + bx - 40 = 0$ has three positive integer roots. Two of the roots are 2 and 4. Find the other root and the value of each of the integers a and b. [4]

(b) **Do not use a calculator in this question.**

Solve the equation $x^3 - 5x^2 - 46x - 40 = 0$ given that it has three integer roots, only one of which is positive. [4]

8 **(i)** A particle A travels with a speed of $6.5\,\text{ms}^{-1}$ in the direction $-5\mathbf{i}-12\mathbf{j}$. Find the velocity, $\boldsymbol{v}_A$, of A. [2]

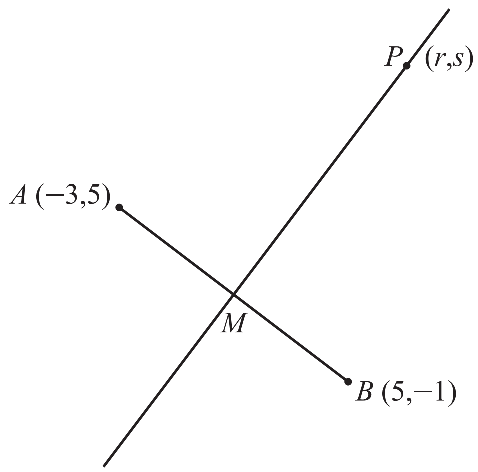
(ii) A particle B travels with velocity $\boldsymbol{v}_B = 12\mathbf{i}-9\mathbf{j}$. Find the speed, in ms^{-1}, of B. [2]

Particle A starts moving from the point with position vector $20\mathbf{i}-7\mathbf{j}$. At the same time particle B starts moving from the point with position vector $-67\mathbf{i}+11\mathbf{j}$.

(iii) Find $\boldsymbol{r}_A$, the position vector of A after t seconds, and $\boldsymbol{r}_B$, the position vector of B after t seconds. [2]

(iv) Find the time when the particles collide and the position vector of the point of collision. [3]

9



The diagram shows the points A (–3, 5) and B (5, –1). The mid-point of AB is M and the line PM is perpendicular to AB. The point P has coordinates (r, s).

(i) Find the equation of the line PM in the form $y = mx + c$, where m and c are exact constants. [5]

(ii) Hence find an expression for s in terms of r. [1]

(iii) Given that the length of *PM* is 10 units, find the value of r and of s. [5]

10 **(i)** Given that $y = \frac{\ln x}{x^2}$, find $\frac{dy}{dx}$. [3]

(ii) Find the coordinates of the stationary point on the curve $y = \frac{\ln x}{x^2}$. [3]

(iii) Using your answer to **part (i)**, find $\int \frac{\ln x}{x^3} \mathrm{d}x$. [3]

(iv) Hence evaluate $\int_1^2 \frac{\ln x}{x^3} \mathrm{d}x$. [2]

Question 11 is printed on the next page.

11 Do not use a calculator in this question.

Solve the quadratic equation $(\sqrt{5}-3)x^2+3x+(\sqrt{5}+3)=0$, giving your answers in the form $a+b\sqrt{5}$, where a and b are constants. [6]

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

Cambridge IGCSE

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3629900230

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **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.
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The total number of marks for this paper is 80.

This document consists of **15** printed pages and **1** blank page.

DC (NH/FC) 172299/2

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 Solve $|3x+2| = x+4$. [3]

2 **(i)** Show that $\dfrac{\operatorname{cosec} x - \cot x}{1 - \cos x} = \operatorname{cosec} x$. [3]

(ii) Hence solve $\dfrac{\operatorname{cosec} x - \cot x}{1 - \cos x} = 2$ for $0° < x < 180°$. [2]

3 The first four terms in the expansion of $(1+ax)^5(2+bx)$ are $2+32x+210x^2+cx^3$, where a, b and c are integers. Show that $3a^2-16a+21=0$ and hence find the values of a, b and c. [8]

4 **(i)** Given that $y = 2x^2 - 4x - 7$, write y in the form $a(x-b)^2 + c$, where a, b and c are constants. [3]

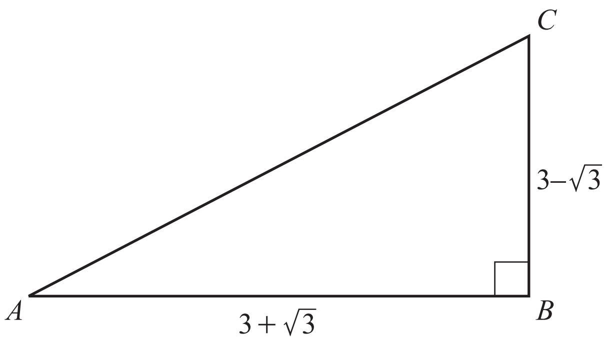
(ii) Hence write down the minimum value of y and the value of x at which it occurs. [2]

(iii) Using your answer to **part (i)**, solve the equation $2p - 4\sqrt{p} - 7 = 0$, giving your answer correct to 2 decimal places. [3]

5 **(a)** Solve $3\cot^2\left(y-\frac{\pi}{4}\right)=1$ for $0 < y < \pi$ radians. [4]

(b) Solve $7\cot z+\tan z=7\operatorname{cosec} z$ for $0° \leqslant z \leqslant 360°$. [6]

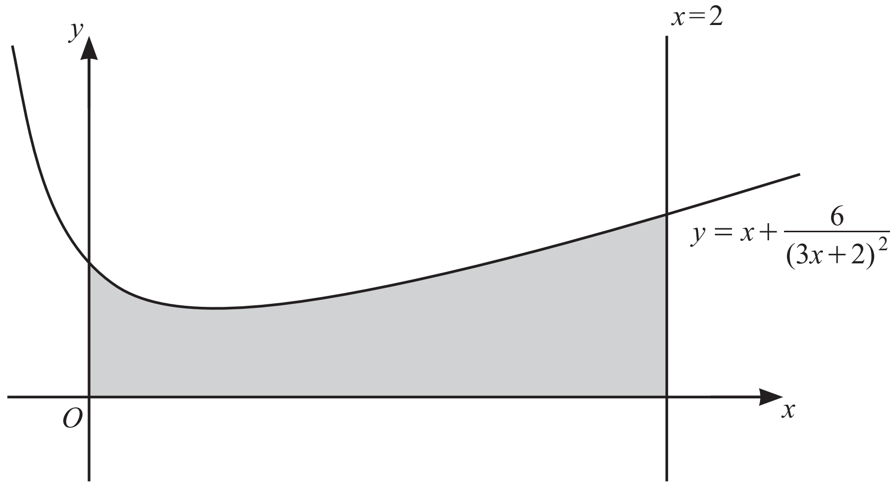
6 Do not use a calculator in this question.



(i) Find tan ACB in the form $r+s\sqrt{3}$, where r and s are integers. [3]

(ii) Find AC in the form $t\sqrt{u}$, where t and u are integers and $t \neq 1$. [3]

7



The diagram shows part of the curve $y = x + \dfrac{6}{(3x+2)^2}$ and the line $x = 2$.

(i) Find, correct to 2 decimal places, the coordinates of the stationary point. [6]

(ii) Find the area of the shaded region, showing all your working. [4]

8 The roots of the equation $x^3 + ax^2 + bx + 24 = 0$ are 2, 3 and p, where p is an integer.

(i) Find the value of p. [1]

(ii) Show that $a = -1$ and find the value of b. [4]

Given that a curve has equation $y = x^3 - x^2 + bx + 24$ find, using your value of b,

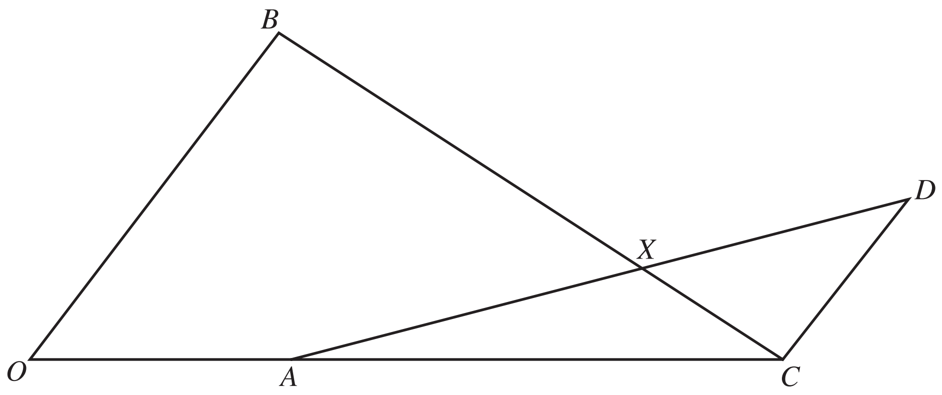
(iii) $\dfrac{dy}{dx}$, [1]

(iv) the integer value of x for which the gradient of the curve is 2 and the corresponding value of y. [3]

The coordinates of the point P on the curve are given by the values of x and y found in **part (iv)**.

(v) Find the equation of the tangent to the curve at P. [1]

9



The diagram shows points O, A, B, C, D and X. The position vectors of A, B, and C relative to O are $\overrightarrow{OA} = \mathbf{a}$, $\overrightarrow{OB} = 2\mathbf{b}$ and $\overrightarrow{OC} = 3\mathbf{a}$. The vector $\overrightarrow{CD} = \mathbf{b}$.

(i) Given that $\overrightarrow{AX} = \lambda\overrightarrow{AD}$, find $\overrightarrow{OX}$ in terms of λ, $\mathbf{a}$ and $\mathbf{b}$. [2]

(ii) Given that $\overrightarrow{BX} = \mu\overrightarrow{BC}$, find $\overrightarrow{OX}$ in terms of μ, $\mathbf{a}$ and $\mathbf{b}$. [2]

(iii) Hence find the value of λ and of μ. [4]

(iv) Find the ratio $\frac{AX}{XD}$. [1]

10 The functions f and g are defined by

$$f(x) = \ln(3x+2) \quad \text{for } x > -\frac{2}{3},$$
$$g(x) = e^{2x} - 4 \quad \text{for } x \in \mathbb{R}.$$

(i) Solve $gf(x) = 5$. [5]

(ii) Find $f^{-1}(x)$. [2]

(iii) Solve $f^{-1}(x) = g(x)$. [4]

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Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2019**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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DC (NF/TP) 165272/1

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

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

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

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

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

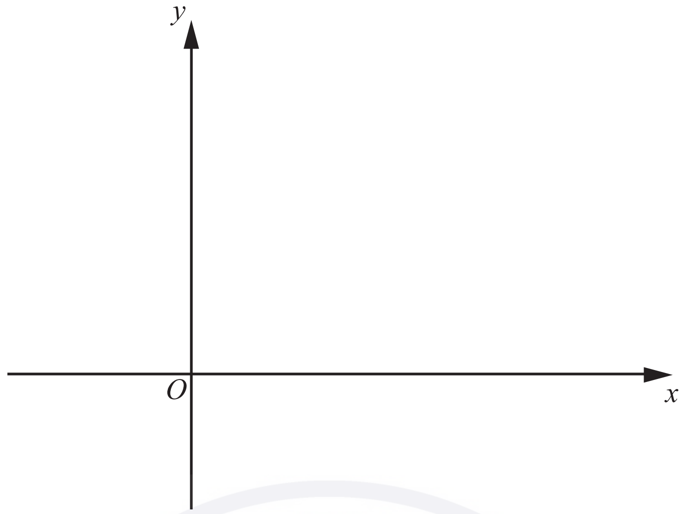
1 Find the values of x for which $x(6x + 7) \geqslant 20$. [3]

2 Two variables x and y are such that $y = \frac{\ln x}{x^3}$ for $x > 0$.

(i) Show that $\frac{dy}{dx} = \frac{1 - 3\ln x}{x^4}$. [3]

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

3 **(i)** Sketch the graph of $y = |5x - 3|$ on the axes below, showing the coordinates of the points where the graph meets the coordinate axes.

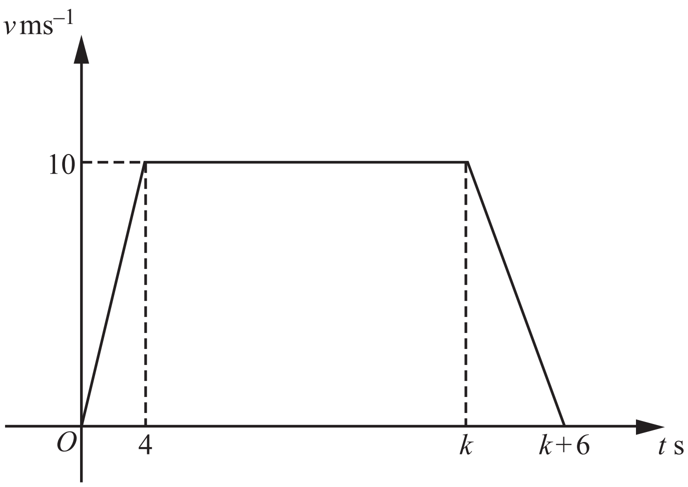


[3]

(ii) Solve the equation $|5x - 3| = 2 - x$. [3]

4 **Without using a calculator**, express $\dfrac{(\sqrt{5}-3)^2}{\sqrt{5}+1}$ in the form $p\sqrt{5} + q$, where p and q are integers. [4]

5



The velocity-time graph represents the motion of a particle travelling in a straight line.

(i) Find the acceleration during the last 6 seconds of the motion. [1]

(ii) The particle travels with constant velocity for 23 seconds. Find the value of k. [1]

(iii) Using your answer to **part (ii)**, find the total distance travelled by the particle. [3]

6 **(a)** $\mathbf{A} = \begin{pmatrix} x+3 & -x \\ 2x & x-3 \end{pmatrix}$

Given that **A** does not have an inverse, find the exact values of x. [3]

(b) $\mathbf{B} = \begin{pmatrix} 0 & 3 \\ -4 & 1 \\ 5 & 2 \end{pmatrix}$ and $\mathbf{C} = \begin{pmatrix} 0 & 1 & 2 \\ 3 & -4 & 5 \end{pmatrix}$

(i) Write down the order of matrix **B**. [1]

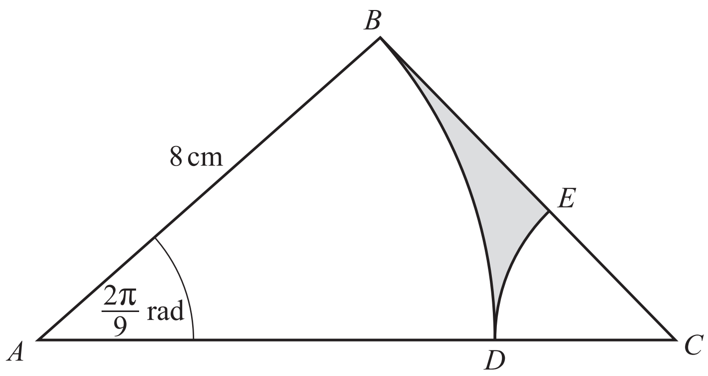
(ii) The matrix $\mathbf{BC} = \begin{pmatrix} 9 & -12 & 15 \\ 3 & -8 & -3 \\ 6 & -3 & 20 \end{pmatrix}$. Explain why $\mathbf{CB} \neq \mathbf{BC}$. [2]

7 The variables x, y and u are such that $y = \tan u$ and $x = u^3 + 1$.

(i) State the rate of change of y with respect to u. [1]

(ii) Hence find the rate of change of y with respect to x, giving your answer in terms of x. [4]

8



The diagram shows a right-angled triangle ABC with $AB = 8\,\text{cm}$ and angle $ABC = \frac{\pi}{2}$ radians. The points D and E lie on AC and BC respectively. BAD and ECD are sectors of the circles with centres A and C respectively. Angle $BAD = \frac{2\pi}{9}$ radians.

(i) Find the area of the shaded region. [6]

(ii) Find the perimeter of the shaded region. [3]

9 **(a)** Eleven different television sets are to be displayed in a line in a large shop.

(i) Find the number of different ways the televisions can be arranged. [1]

Of these television sets, 6 are made by company *A* and 5 are made by company *B*.

(ii) Find the number of different ways the televisions can be arranged so that no two sets made by company *A* are next to each other. [2]

(b) A group of people is to be selected from 5 women and 3 men.

(i) Calculate the number of different groups of 4 people that have exactly 3 women. [2]

(ii) Calculate the number of different groups of at most 4 people where the number of women is the same as the number of men. [2]

10 Solutions to this question by accurate drawing will not be accepted.

The points A and B have coordinates $(p, 3)$ and $(1, 4)$ respectively and the line L has equation $3x + y = 2$.

(i) Given that the gradient of AB is $\frac{1}{3}$, find the value of p. [2]

(ii) Show that L is the perpendicular bisector of AB. [3]

(iii) Given that $C(q, -10)$ lies on L, find the value of q. [1]

(iv) Find the area of triangle ABC. [2]

11 **(a)** **(i)** Show that $\dfrac{\operatorname{cosec}\theta - \cot\theta}{\sin\theta} = \dfrac{1}{1+\cos\theta}$. [4]

(ii) Hence solve $\dfrac{\operatorname{cosec}\theta - \cot\theta}{\sin\theta} = \dfrac{5}{2}$ for $180° < \theta < 360°$. [2]

(b) Solve $\tan\left(3\phi - 4\right) = -\frac{1}{2}$ for $0 \leqslant \phi \leqslant \frac{\pi}{2}$ radians. [3]

12 **(a)** Given that $\int_0^a e^{2x}\,dx = 50$, find the exact value of a. You must show all your working. [4]

(b) A curve is such that $\frac{\mathrm{d}y}{\mathrm{d}x} = 3 - 2\cos 5x$. The curve passes through the point $\left(\frac{\pi}{5}, \frac{8\pi}{5}\right)$.

(i) Find the equation of the curve. [4]

(ii) Find $\int y\,\mathrm{d}x$ and hence evaluate $\int_{\frac{\pi}{2}}^{\pi} y\,\mathrm{d}x$. [5]

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Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

3034680663

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2019**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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The total number of marks for this paper is 80.

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

DC (LK) 165275/2

Cambridge Assessment International Education

[Turn over

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

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

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

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

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

1 Given that $y = \dfrac{\sin x}{\ln x^2}$, find an expression for $\dfrac{\mathrm{d}y}{\mathrm{d}x}$. [4]

2 Find the values of k for which the equation $(k-1)x^2 + kx - k = 0$ has real and distinct roots. [4]

3 **(i)** Given that $x-2$ is a factor of ax^3-12x^2+5x+6, use the factor theorem to show that $a=4$. [2]

(ii) Showing all your working, factorise $4x^3-12x^2+5x+6$ and hence solve $4x^3-12x^2+5x+6=0$. [4]

4 A circle has diameter x which is increasing at a constant rate of $0.01\,\text{cm}\,\text{s}^{-1}$. Find the exact rate of change of the area of the circle when $x = 6\,\text{cm}$. [5]

5 **(i)** Express $5x^2 - 15x + 1$ in the form $p(x+q)^2 + r$, where p, q and r are constants. [3]

(ii) Hence state the least value of $x^2 - 3x + 0.2$ and the value of x at which this occurs. [2]

6 **(a)** State the order of the matrix $\begin{pmatrix} 0 & 1 & 4 & 8 \\ 5 & 8 & 1 & 6 \end{pmatrix}$. [1]

(b) $\mathbf{A} = \begin{pmatrix} 2 & -4 \\ -1 & 3 \end{pmatrix}$

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

(ii) Hence, given that $\mathbf{ABA} = \mathbf{I}$, find the matrix $\mathbf{B}$. [3]

7 **(a)** Solve $\lg(x^2 - 3) = 0$. [2]

(b) **(i)** Show that, for $a > 0$, $\dfrac{\ln a^{\sin(2x+5)} + \ln\left(\frac{1}{a}\right)}{\ln a}$ may be written as $\sin(2x+5) + k$, where k is an integer. [3]

(ii) Hence find $\displaystyle\int \frac{\ln a^{\sin(2x+5)} + \ln\left(\frac{1}{a}\right)}{\ln a}\,dx$. [3]

8 **(a)** In the binomial expansion of $\left(a-\frac{x}{2}\right)^6$, the coefficient of x^3 is 120 times the coefficient of x^5. Find the possible values of the constant a. [4]

(b) **(i)** Expand $(1+2x)^{20}$ in ascending powers of x, as far as the term in x^3. Simplify each term. [2]

(ii) Use your expansion to show that the value of 0.98^{20} is 0.67 to 2 decimal places. [2]

9 **(a)** Solve $6\sin^2 x - 13\cos x = 1$ for $0° \leqslant x \leqslant 360°$. [4]

(b) **(i)** Show that, for $-\frac{\pi}{2} < y < \frac{\pi}{2}$, $\frac{4\tan y}{\sqrt{1+\tan^2 y}}$ can be written in the form $a\sin y$, where a is an integer. [3]

(ii) Hence solve $\frac{4\tan y}{\sqrt{1+\tan^2 y}} + 3 = 0$ for $-\frac{\pi}{2} < y < \frac{\pi}{2}$ radians. [1]

10 **(a)** Find the unit vector in the direction of $5\mathbf{i} - 15\mathbf{j}$. [2]

(b) The position vectors of points A and B relative to an origin O are $\begin{pmatrix} 3 \\ -5 \end{pmatrix}$ and $\begin{pmatrix} 12 \\ 7 \end{pmatrix}$ respectively. The point C lies on AB such that $AC : CB$ is $2 : 1$.

(i) Find the position vector of C relative to O. [3]

The point D lies on OB such that $OD : OB$ is $1 : \lambda$ and $\overrightarrow{DC} = \begin{pmatrix} 6 \\ 1.25 \end{pmatrix}$.

(ii) Find the value of λ. [3]

11 The velocity, $v\ \mathrm{m\,s^{-1}}$, of a particle travelling in a straight line, t seconds after passing through a fixed point O, is given by $v = \dfrac{4}{(t+1)^3}$.

(i) Explain why the direction of motion of the particle never changes. [1]

(ii) Showing all your working, find the acceleration of the particle when $t = 5$. [3]

(iii) Find an expression for the displacement of the particle from O after t seconds. [3]

(iv) Find the distance travelled by the particle in the fourth second. [2]

12 **(a)** The functions f and g are defined by

$$f(x) = 5x - 2 \quad \text{for } x > 1,$$
$$g(x) = 4x^2 - 9 \quad \text{for } x > 0.$$

(i) State the range of g. [1]

(ii) Find the domain of gf. [1]

(iii) Showing all your working, find the exact solutions of $gf(x) = 4$. [3]

Question 12(b) is printed on the next page.

(b) The function h is defined by $\mathrm{h}(x) = \sqrt{x^2 - 1}$ for $x \leqslant -1$.

(i) State the geometrical relationship between the graphs of $y = \mathrm{h}(x)$ and $y = \mathrm{h}^{-1}(x)$. [1]

(ii) Find an expression for $\mathrm{h}^{-1}(x)$. [3]

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

9164116781

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2019**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

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DC (SC/CB) 165277/2

Cambridge Assessment International Education

Mathematical Formulae

1. ALGEBRA

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

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

1 Find the values of x for which $9x^2 + 18x - 1 < x + 1$. [3]

2 Differentiate $\tan 3x \cos \frac{x}{2}$ with respect to x. [4]

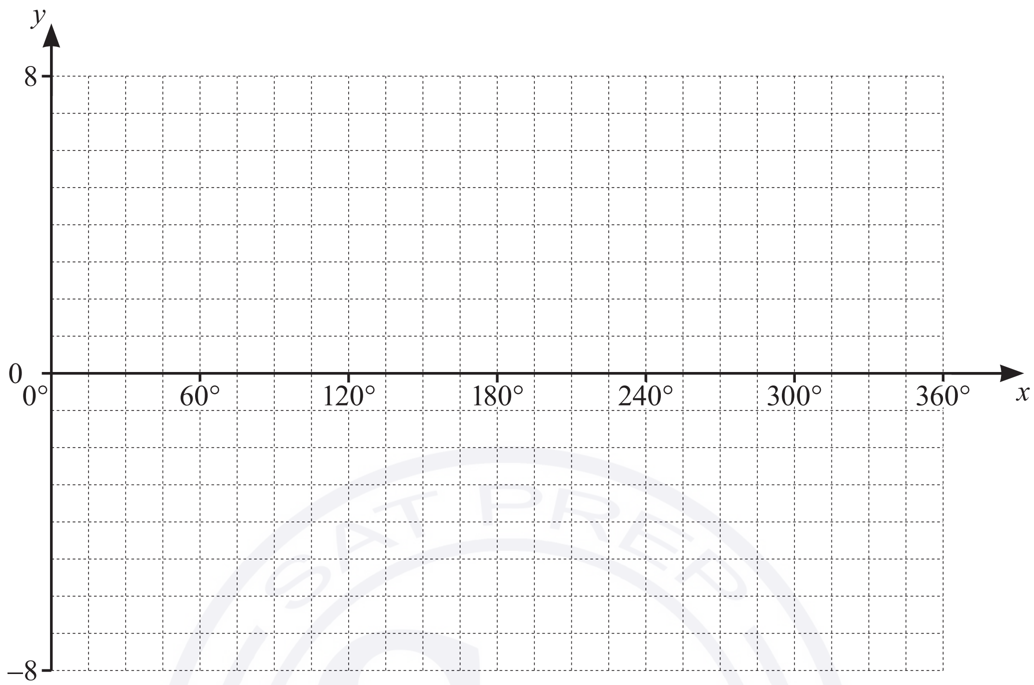
3 The points A, B and C have coordinates $(4, 7)$, $(-3, 9)$ and $(6, 4)$ respectively.

(i) Find the equation of the line, L, that is parallel to the line AB and passes through C. Give your answer in the form $ax + by = c$, where a, b and c are integers. [3]

(ii) The line L meets the x-axis at the point D and the y-axis at the point E. Find the length of DE. [2]

4 The function f is defined, for $0° \leqslant x \leqslant 360°$, by $f(x) = 4 + 3\sin 2x$.

(i) Sketch the graph of $y = f(x)$ on the axes below.



[3]

(ii) State the period of f. [1]

(iii) State the amplitude of f. [1]

5 **(a)** Given that $\mathbf{A} = \begin{pmatrix} 2 & 3 \\ 0 & -1 \\ 6 & 4 \end{pmatrix}$ and that $\mathbf{A} + \mathbf{O} = \mathbf{A}$,

(i) state the order of the matrix **A**, [1]

(ii) write down the matrix **O**. [1]

(b) $\mathbf{B} = \begin{pmatrix} 1 & -1 \\ 3 & 2 \end{pmatrix}$ and $\mathbf{C} = \begin{pmatrix} 0.4 & 0.2 \\ -0.6 & 0.2 \end{pmatrix}$.

Find the matrix product **BC** and state a relationship between **B** and **C**. [2]

(c) $\mathbf{D} = \begin{pmatrix} a & 4a \\ -1 & 5 \end{pmatrix}$, where a is a positive integer. Find $\mathbf{D}^{-1}$ in terms of a. [2]

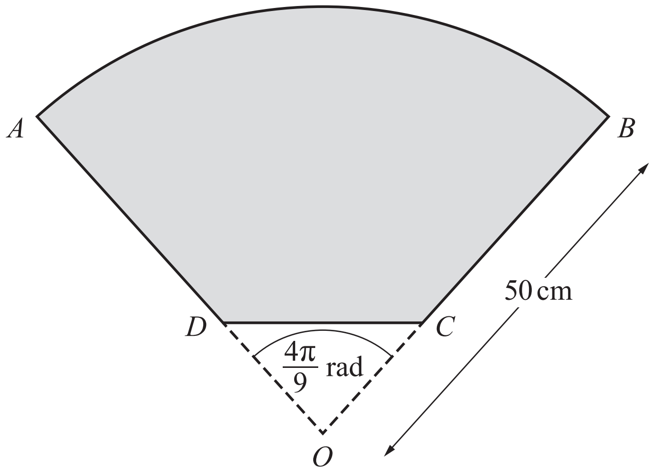
6 A curve has equation $y = (3x-5)^3 - 2x$.

(i) Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$. [4]

(ii) Find the exact value of the x-coordinate of each of the stationary points of the curve. [2]

(iii) Use the second derivative test to determine the nature of each of the stationary points. [2]

7



The diagram shows a company logo, *ABCD*. The logo is part of a sector, *AOB*, of a circle, centre *O* and radius 50 cm. The points *C* and *D* lie on *OB* and *OA* respectively. The lengths *AD* and *BC* are equal and *AD* : *AO* is 7 : 10. The angle *AOB* is $\frac{4\pi}{9}$ radians.

(i) Find the perimeter of *ABCD*. [5]

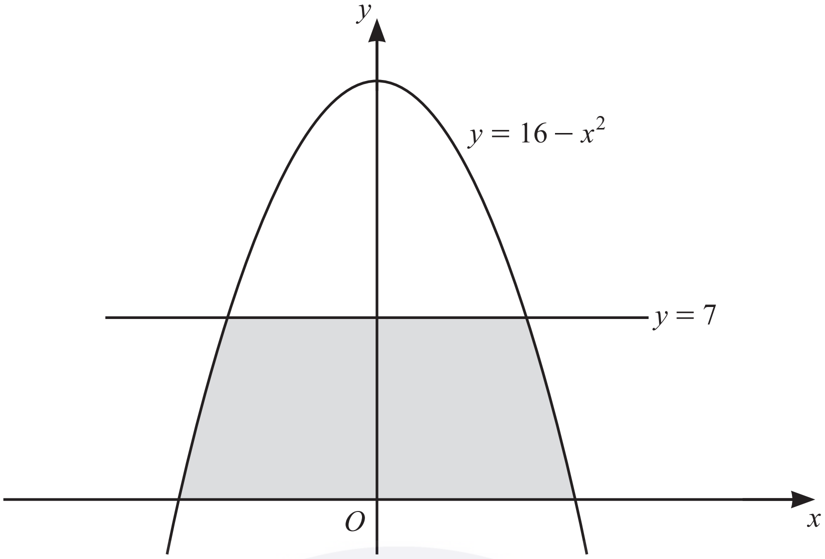
(ii) Find the area of *ABCD*. [3]

8 **(a)** **(i)** Given that $\left(x^2 - \dfrac{1}{px}\right)^8 = x^{16} - 4x^{13} + qx^{10} + rx^7 + \ldots,$ find the value of each of the constants p, q and r. [3]

(ii) Explain why there is no term independent of x in the binomial expansion of $\left(x^2 - \dfrac{1}{px}\right)^8$. [1]

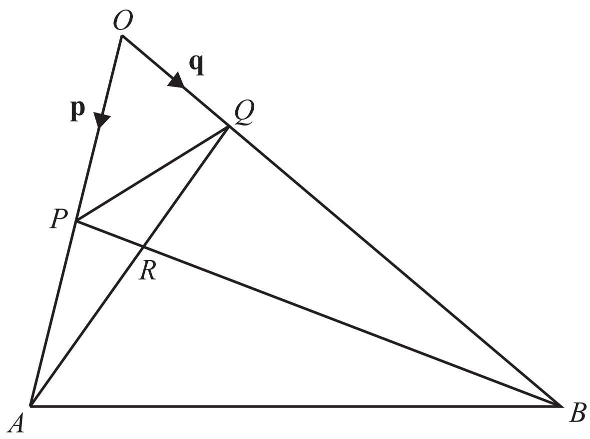
(b) In the binomial expansion of $\left(1 - \dfrac{\sqrt{x}}{2}\right)^n$, where n is a positive integer, the coefficient of x is 30. Form an equation in n and hence find the value of n. [4]

9



The diagram shows the curve $y = 16 - x^2$ and the straight line $y = 7$. Find the area of the shaded region. You must show all your working. [6]

10



The diagram shows a triangle *OAB*. The point *P* is the midpoint of *OA* and the point *Q* lies on *OB* such that $\overrightarrow{OQ} = \frac{1}{4}\overrightarrow{OB}$. The position vectors of *P* and *Q* relative to *O* are **p** and **q** respectively.

(i) Find, in terms of **p** and **q**, an expression for each of the vectors $\overrightarrow{PQ}$, $\overrightarrow{QA}$ and $\overrightarrow{PB}$. [3]

(ii) Given that $\overrightarrow{PR} = \lambda\overrightarrow{PB}$ and that $\overrightarrow{QR} = \mu\overrightarrow{QA}$, find an expression for $\overrightarrow{PQ}$ in terms of λ, μ, **p** and **q**. [2]

(iii) Using your expressions for $\overrightarrow{PQ}$, find the value of λ and of μ. [4]

11 A particle travelling in a straight line passes through a fixed point O. The displacement, x metres, of the particle, t seconds after it passes through O, is given by $x = 5t + \sin t$.

(i) Show that the particle is never at rest. [2]

(ii) Find the distance travelled by the particle between $t = \frac{\pi}{3}$ and $t = \frac{\pi}{2}$. [2]

(iii) Find the acceleration of the particle when $t = 4$. [2]

(iv) Find the value of t when the velocity of the particle is first at its minimum. [2]

Question 12 is printed on the next page.

12 Do not use a calculator in this question.

The line $y = 4x - 6$ intersects the curve $y = 10x^3 - 19x^2 - x$ at the points A, B, and C. Given that C is the point (2, 2), find the coordinates of the midpoint of AB. [10]

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

1438509375

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **February/March 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.
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DO **NOT** WRITE IN ANY BARCODES.

Answer **all** the questions.
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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 **14** printed pages and **2** blank pages.

DC (KS/TP) 165271/2

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 A band can play 25 different pieces of music. From these pieces of music, 8 are to be selected for a concert.

(i) Find the number of different ways this can be done. [1]

The 8 pieces of music are then arranged in order.

(ii) Find the number of different arrangements possible. [1]

The band has 15 members. Three members are chosen at random to be the treasurer, secretary and agent.

(iii) Find the number of ways in which this can be done. [1]

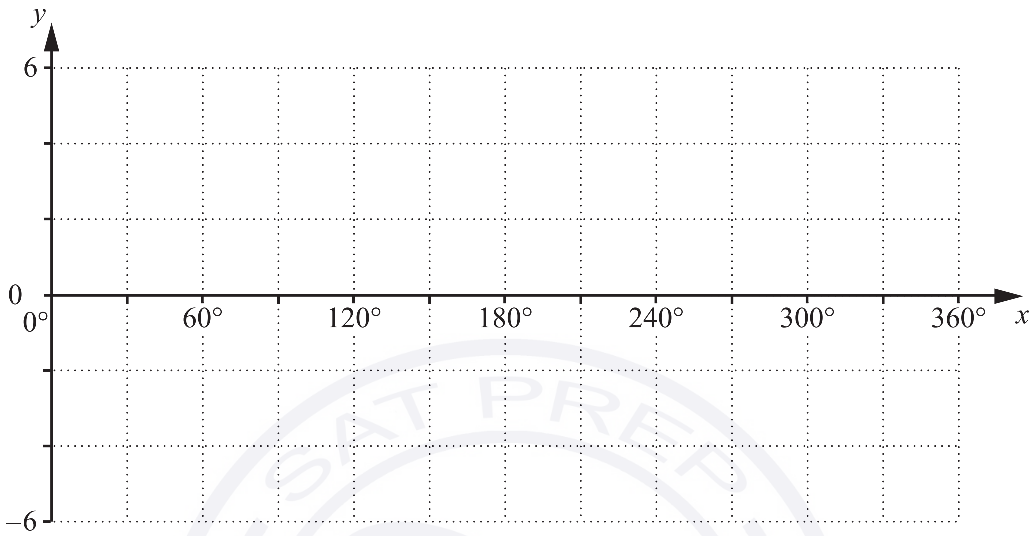
2 Variables x and y are related by the equation $y = \frac{\ln x}{e^x}$.

(i) Show that $\frac{dy}{dx} = \frac{1 - x\ln x}{xe^x}$. [4]

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

3 The function f is defined, for $0^\circ \leqslant x \leqslant 360^\circ$, by $f(x) = a + b\sin cx$, where a, b and c are constants with $b > 0$ and $c > 0$. The graph of $y = f(x)$ meets the y-axis at the point $(0, -1)$, has a period of $120°$ and an amplitude of 5.

(i) Sketch the graph of $y = f(x)$ on the axes below. [3]



(ii) Write down the value of each of the constants a, b and c. [2]

a = ... b = ... c = ...

4 **(a)** Find the values of x for which $(2x+1)^2 \leqslant 3x+4$. [3]

(b) Show that, whatever the value of k, the equation $\frac{x^2}{4}+kx+k^2+1=0$ has no real roots. [3]

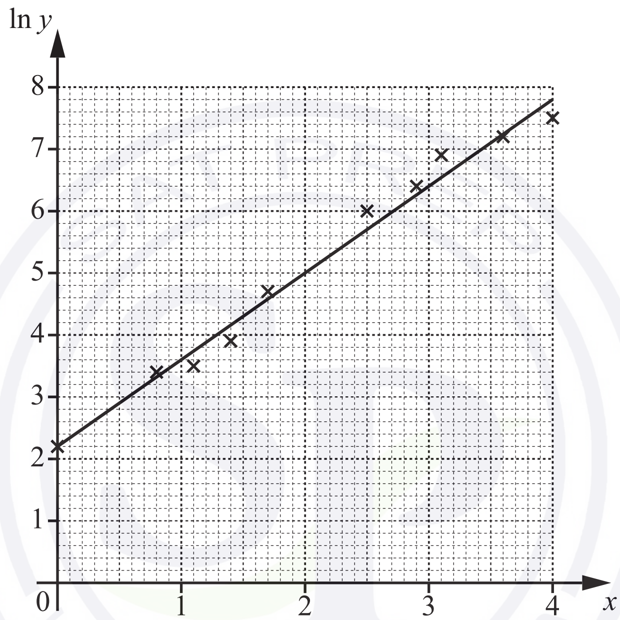
5 Solutions to this question by accurate drawing will not be accepted.

The points $A(3, 2)$, $B(7, -4)$, $C(2, -3)$ and $D(k, 3)$ are such that CD is perpendicular to AB. Find the equation of the perpendicular bisector of CD. [6]

6 The relationship between experimental values of two variables, x and y, is given by $y = Ab^x$, where A and b are constants.

(i) Transform the relationship $y = Ab^x$ into straight line form. [2]

The diagram shows $\ln y$ plotted against x for ten different pairs of values of x and y. The line of best fit has been drawn.



(ii) Find the equation of the line of best fit and the value, correct to 1 significant figure, of A and of b. [4]

(iii) Find the value, correct to 1 significant figure, of y when $x = 2.7$. [2]

7 **(i)** Given that $y = x\sqrt{x^2+1}$, show that $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{ax^2+b}{\left(x^2+1\right)^p}$, where a, b and p are positive constants. [4]

(ii) Explain why the graph of $y = x\sqrt{x^2+1}$ has no stationary points. [2]

8 Relative to an origin O, the position vectors of the points A and B are $2\mathbf{i} + 12\mathbf{j}$ and $6\mathbf{i} - 4\mathbf{j}$ respectively.

(i) Write down and simplify an expression for $\overrightarrow{AB}$. [2]

The point C lies on $\overrightarrow{AB}$ such that $AC : CB$ is $1 : 3$.

(ii) Find the unit vector in the direction of $\overrightarrow{OC}$. [4]

The point D lies on $\overrightarrow{OA}$ such that $OD : DA$ is $1 : \lambda$.

(iii) Find an expression for $\overrightarrow{AD}$ in terms of λ, $\mathbf{i}$ and $\mathbf{j}$. [2]

9 **(a)** It is given that $g(x) = 6x^4 + 5$ for all real x.

(i) Explain why g is a function but does not have an inverse. [2]

(ii) Find $g^2(x)$ and state its domain. [2]

It is given that $h(x) = 6x^4 + 5$ for $x \leqslant k$.

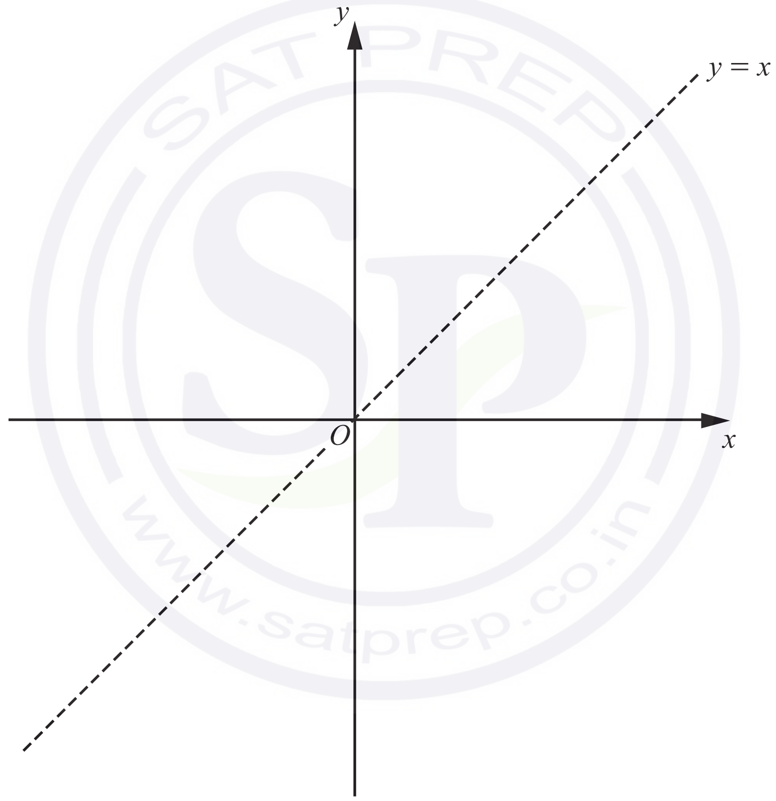
(iii) State the greatest value of k such that h^{-1} exists. [1]

(iv) For this value of k, find $h^{-1}(x)$. [3]

(b) The function p is defined by $\mathrm{p}(x) = 3\mathrm{e}^{x} + 2$ for all real x.

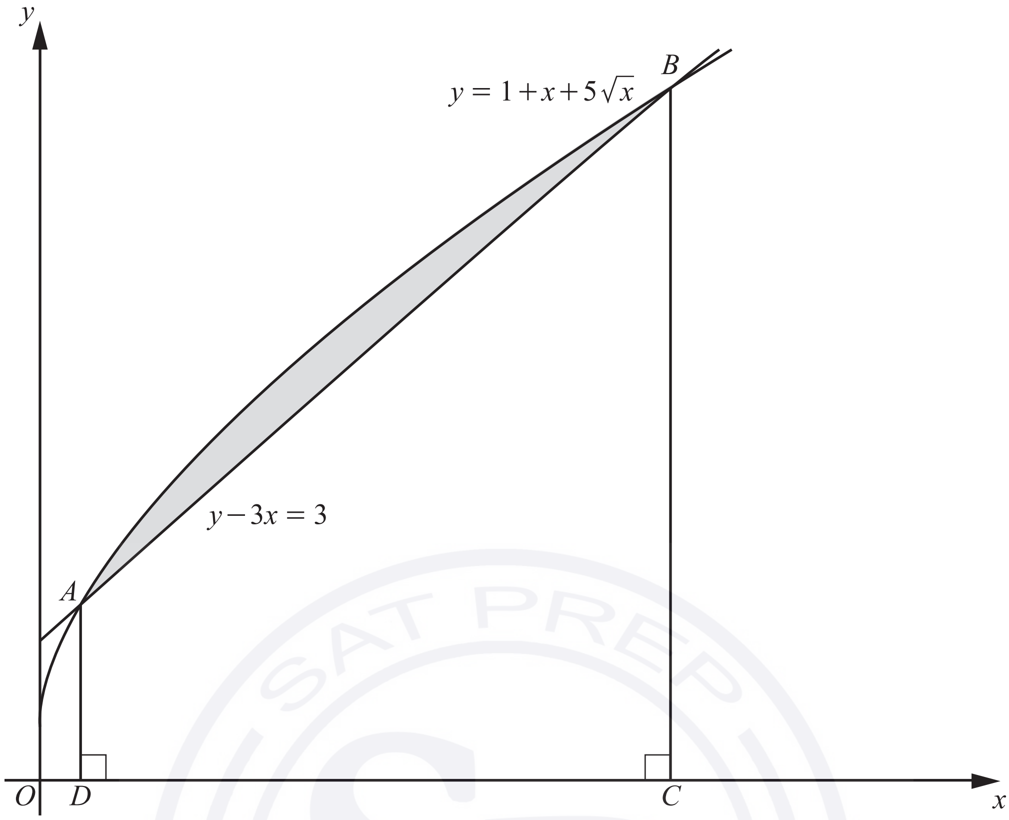
(i) State the range of p. [1]

(ii) On the axes below, sketch and label the graphs of $y = \mathrm{p}(x)$ and $y = \mathrm{p}^{-1}(x)$. State the coordinates of any points of intersection with the coordinate axes. [3]



(iii) Hence explain why the equation $\mathrm{p}(x) = \mathrm{p}^{-1}(x)$ has no solutions. [1]

10



The diagram shows the curve $y = 1 + x + 5\sqrt{x}$ and the straight line $y - 3x = 3$. The curve and line intersect at the points A and B. The lines BC and AD are perpendicular to the x-axis.

(i) Using the substitution $u^2 = x$, or otherwise, find the coordinates of A and of B. You must show all your working. [6]

(ii) Find the area of the shaded region, showing all your working. [6]

11 **(a)** Find $\int \frac{x^2(x^6+1)}{x^6}\,dx$. [3]

(b) **(i)** Find $\int \cos(4\theta - 5)\,d\theta$. [2]

(ii) Hence evaluate $\int_{1.25}^{2} \cos(4\theta - 5)\,d\theta$. [2]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

1207805813

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2018**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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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.

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DC (ST/JG) 153499/2

CAMBRIDGE
International Examinations

[Turn over

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

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

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

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

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 Solve the inequality $(2-x)(x+9) < 10$. [4]

2 **(a)** Solve $3^{\left(\frac{x}{2}-1\right)} = 10$. [3]

(b) Solve $2e^{1-2y} = 3e^{3y+2}$. [4]

3 Do not use a calculator in this question.

(a) Simplify $(\sqrt{2}+2\sqrt{5})(4\sqrt{2}-3\sqrt{5})$, giving your answer in the form $a+b\sqrt{c}$, where a, b and c are integers. [3]

(b) Simplify $\dfrac{4-3\sqrt{6}}{\sqrt{3}+\sqrt{2}}$, giving your answer in the form $p\sqrt{3}+q\sqrt{2}$, where p and q are integers. [4]

4 Solve $\sec x = \cot x - 5\tan x$ for $0° < x < 360°$. [6]

5 $\mathbf{A} = \begin{pmatrix} 3 & 2 \\ -1 & 1 \end{pmatrix}$.

(i) Find $\mathbf{A}^2$. [2]

(ii) Find constants p and q such that $p\mathbf{A}^2 + q\mathbf{A} = \mathbf{I}$. [4]

6 A 5-digit code is to be formed from the digits 1, 2, 3, 4, 5, 6, 7, 8, 9. Each digit can be used once only in any code. Find how many codes can be formed if

(i) the first digit of the code is 6 and the other four digits are odd, [2]

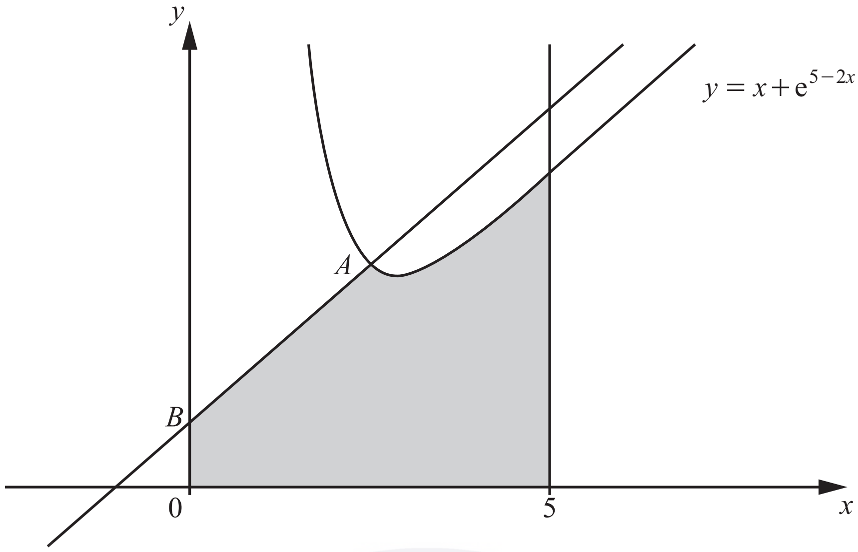
(ii) each of the first three digits is even, [2]

(iii) the first and last digits are prime. [2]

7 **(i)** Show that $\dfrac{1}{1-\cos x} - \dfrac{1}{1+\cos x} = 2\operatorname{cosec} x \cot x$. [4]

(ii) Hence solve the equation $\dfrac{1}{1-\cos x} - \dfrac{1}{1+\cos x} = \sec x$ for $0 \leqslant x \leqslant 2\pi$ radians. [4]

8

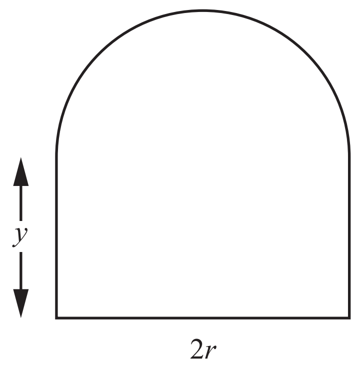


The diagram shows part of the curve $y = x + e^{5-2x}$, the normal to the curve at the point A and the line $x = 5$. The normal to the curve at A meets the y-axis at the point B. The x-coordinate of A is 2.5.

(i) Find the equation of the normal AB. [4]

(ii) Showing all your working, find the area of the shaded region. [6]

9 In this question, all lengths are in metres.



The diagram shows a window formed by a semi-circle of radius r on top of a rectangle with dimensions $2r$ by y. The total perimeter of the window is 5.

(i) Find y in terms of r. [2]

(ii) Show that the total area of the window is $A = 5r - \frac{\pi r^2}{2} - 2r^2$. [2]

(iii) Given that r can vary, find the value of r which gives a maximum area of the window and find this area. (You are not required to show that this area is a maximum.) [5]

10 The line $y = 12 - 2x$ is a tangent to two curves. Each curve has an equation of the form $y = k + 6 + kx - x^2$, where k is a constant.

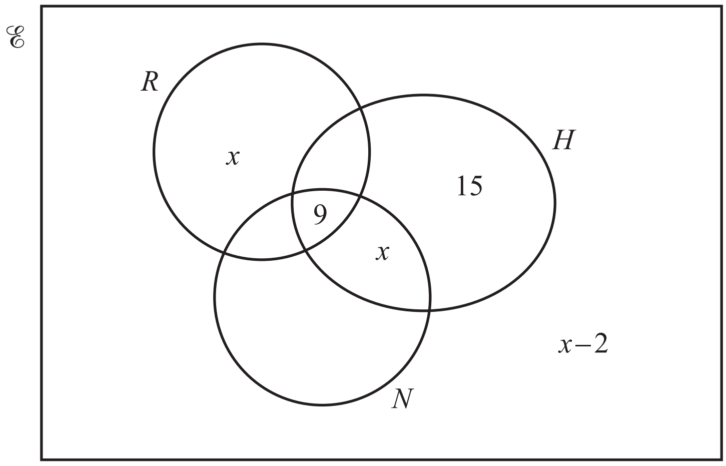
(i) Find the two values of k. [5]

The line $y = 12 - 2x$ is a tangent to one curve at the point A and the other curve at the point B.

(ii) Find the coordinates of A and of B. [3]

(iii) Find the equation of the perpendicular bisector of AB. [3]

11



There are 70 girls in a year group at a school. The Venn diagram gives **some** information about the numbers of these girls who play rounders (R), hockey (H) and netball (N).

$n(R) = 28$ $n(H) = 38$ $n(N) = 35$.

Find the value of x and hence the number of girls who play netball only. [6]

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME		
CENTRE NUMBER		
CANDIDATE NUMBER		

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **October/November 2018**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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Write in dark blue or black pen.
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The total number of marks for this paper is 80.

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DC (SC/CGW) 153503/3

CAMBRIDGE
International Examinations

[Turn over

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

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

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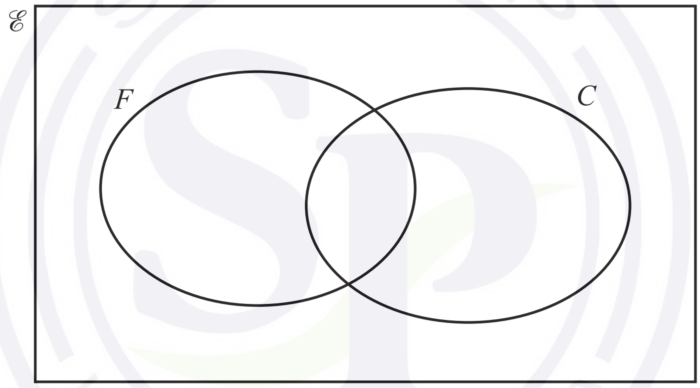
$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

1 Solve the inequality $(x-3)(x+4) > x+13$. [3]

2



There are 105 boys in a year group at a school. Some boys play football (F) and some play cricket (C).

- x boys play both football and cricket.
- The number of boys that play neither game is the same as the number of boys that play both.
- 40 boys play cricket.
- The number of boys that only play football is twice the number of boys that only play cricket.

Complete the Venn diagram and find the value of x. [5]

3 A curve has equation $y = \dfrac{x^3}{\sin 2x}$. Find

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

(ii) the equation of the tangent to the curve at the point where $x = \dfrac{\pi}{4}$. [3]

4 Solve

(i) $2^{3x-1} = 6$, [3]

(ii) $\log_3(y+14) = 1 + \dfrac{2}{\log_y 3}$. [5]

5 Solve the simultaneous equations

$$\frac{8^{p+1}}{4^{q}} = 2^{11},$$

$$\frac{3^{2p+5}}{27^{\frac{1}{3}}} = 9^{3q}.$$

[5]

6 **(a)** A 5-character code is to be formed from the 13 characters shown below. Each character may be used once only in any code.

Letters : A, B, C, D, E, F

Numbers: 1, 2, 3, 4, 5, 6, 7

Find the number of different codes in which no two letters follow each other and no two numbers follow each other. [3]

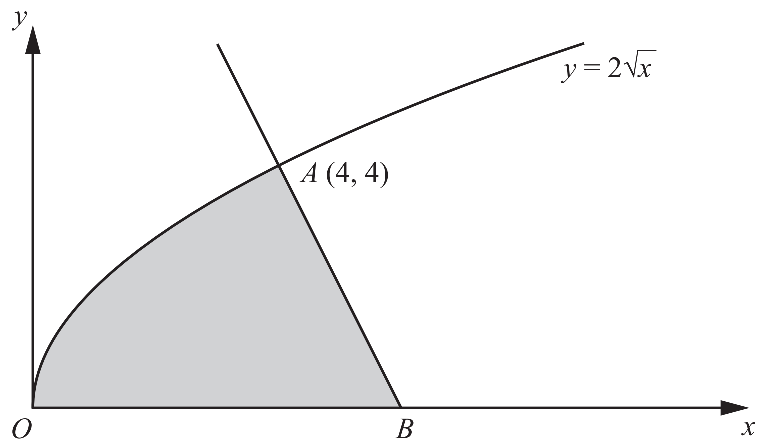
(b) A netball team of 7 players is to be chosen from 10 girls. 3 of these 10 girls are sisters. Find the number of different ways the team can be chosen if the team does not contain all 3 sisters. [3]

7 Solve the quadratic equation $\left(1-\sqrt{3}\right)x^2+x+\left(1+\sqrt{3}\right)=0$, giving your answer in the form $a+b\sqrt{3}$, where a and b are constants. [6]

8 **(i)** Show that $\dfrac{1}{1-\sin x} - \dfrac{1}{1+\sin x} = 2\tan x \sec x$. [4]

(ii) Hence solve the equation $\dfrac{1}{1-\sin x} - \dfrac{1}{1+\sin x} = \operatorname{cosec} x$ for $0° \leqslant x \leqslant 360°$. [4]

9



The diagram shows part of the curve $y = 2\sqrt{x}$. The normal to the curve at the point A (4, 4) meets the x-axis at the point B.

(i) Find the equation of the line AB. [4]

(ii) Find the coordinates of B. [1]

(iii) Showing all your working, find the area of the shaded region. [4]

10 Two lines are tangents to the curve $y = 12 - 4x - x^2$. The equation of each tangent is of the form $y = 2k + 1 - kx$, where k is a constant.

(i) Find the two possible values of k. [5]

(ii) Find the coordinates of the point of intersection of the two tangents. [4]

11 The functions f and g are defined for real values of $x \geqslant 1$ by

$$f(x) = 4x - 3,$$

$$g(x) = \frac{2x+1}{3x-1}.$$

(i) Find $gf(x)$. [2]

(ii) Find $g^{-1}(x)$. [3]

(iii) Solve $fg(x) = x - 1$. [4]

12 A plane that can travel at 260 km/h in still air heads due North. A wind with speed 40 km/h from a bearing of 310° blows the plane off course. Find the resultant speed of the plane and its direction as a bearing correct to 1 decimal place. [6]

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

7180504136

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2018**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

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CAMBRIDGE
International Examinations

Mathematical Formulae

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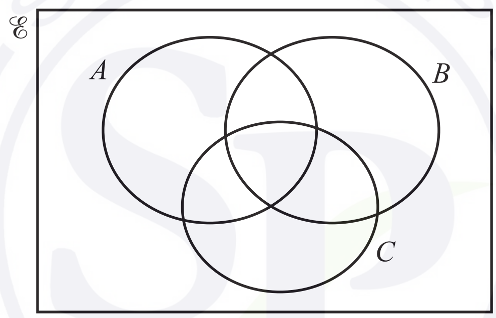
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

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

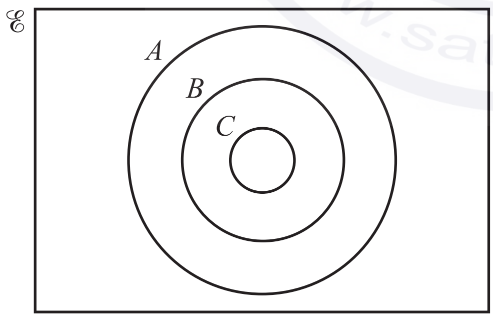
$$\Delta = \frac{1}{2}\,bc\sin A$$

1 Solve the equation $|5x-3| = -3x+13$. [3]

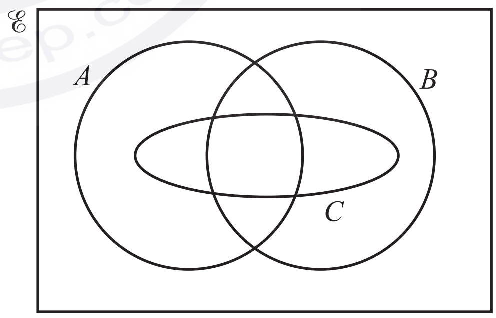
2 On each of the Venn diagrams below, shade the region indicated.



$(A \cup B \cup C)'$



$A \cap B \cap C'$



$(A \cap B) \cup C'$

[3]

3 **(i)** Write $8+7x-x^2$ in the form $a-(x-b)^2$, where a and b are constants. [3]

(ii) Hence state the maximum value of $8+7x-x^2$ and the value of x at which it occurs. [2]

(iii) Using your answer to **part (i)**, or otherwise, solve the equation $8+7z^2-z^4=0$. [3]

4 $$\frac{d^2y}{dx^2} = 2x + \frac{3}{(x+1)^4}$$

(i) Find $\frac{dy}{dx}$, given that $\frac{dy}{dx} = 1$ when $x = 1$. [3]

(ii) Find y in terms of x, given that $y = 3$ when $x = 1$. [3]

5 Given that $\mathbf{A} = \begin{pmatrix} 2 & 3 \\ 1 & 4 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 1 & 4 \\ -2 & 5 \end{pmatrix}$, find

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

(ii) the matrix $\mathbf{C}$ such that $\mathbf{CA} = \mathbf{B}$, [2]

(iii) the matrix $\mathbf{D}$ such that $\mathbf{A}^{-1}\mathbf{D} + \mathbf{B} = \mathbf{I}$. [3]

6 Solve the simultaneous equations

$$\log_2(x+2y) = 3,$$

$$\log_2 3x - \log_2 y = 1.$$

[5]

7 A squad of 20 boys, which includes 2 sets of twins, is available for selection for a cricket team of 11 players. Calculate the number of different teams that can be selected if

(i) there are no restrictions, [1]

(ii) both sets of twins are selected, [2]

(iii) one set of twins is selected but neither twin from the other set is selected, [2]

(iv) exactly one twin from each set of twins is selected. [2]

8 Variables x and y are such that when y^2 is plotted against e^{2x} a straight line is obtained which passes through the points (1.5, 5.5) and (3.7, 12.1). Find

(i) y in terms of e^{2x}, [3]

(ii) the value of y when $x = 3$, [1]

(iii) the value of x when $y = 50$. [3]

9 **(a)** Solve $2\sin\left(x+\frac{\pi}{4}\right)=\sqrt{3}$ for $0 < x < \pi$ radians. [3]

(b) Solve $3\sec y = 4\operatorname{cosec} y$ for $0° < y < 360°$. [3]

(c) Solve $7\cot z - \tan z = 2\operatorname{cosec} z$ for $0° < z < 360°$. [6]

10 The equation of a curve is $y = x^2\sqrt{3+x}$ for $x \geqslant -3$.

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

(ii) Find the equation of the tangent to the curve $y = x^2\sqrt{3+x}$ at the point where $x = 1$. [3]

(iii) Find the coordinates of the turning points of the curve $y = x^2\sqrt{3+x}$. [4]

11 A line with equation $y = -5x + k + 5$ is a tangent to a curve with equation $y = 7 - kx - x^2$.

(i) Find the two possible values of k. [5]

(ii) Find, for **each** of your values of k,

- the equation of the tangent
- the equation of the curve
- the coordinates of the point of contact of the tangent and the curve. [5]

(iii) Find the distance between the two points of contact. [2]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6234149436

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2018**

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.
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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 **15** printed pages and **1** blank page.

DC (NF/SW) 145871/1

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

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

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

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

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 A, B and C are subsets of the same universal set.

(i) Write each of the following statements in words.

(a) $A \not\subset B$ [1]

(b) $A \cap C = \varnothing$ [1]

(ii) Write each of the following statements in set notation.

(a) There are 3 elements in set A or B or both. [1]

(b) x is an element of A but it is not an element of C. [1]

2 The variables x and y are such that $y = \ln(3x-1)$ for $x > \frac{1}{3}$.

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

(ii) Hence find the approximate change in x when y increases from $\ln(1.2)$ to $\ln(1.2) + 0.125$. [3]

3 A 7-character password is to be selected from the 12 characters shown in the table. Each character may be used only once.

	Characters			
Upper-case letters	A	B	C	D
Lower-case letters	e	f	g	h
Digits	1	2	3	4

Find the number of different passwords

(i) if there are no restrictions, [1]

(ii) that start with a digit, [1]

(iii) that contain 4 upper-case letters and 3 lower-case letters such that all the upper-case letters are together and all the lower-case letters are together. [3]

4 Do not use a calculator in this question.

It is given that $x+4$ is a factor of $\mathrm{p}(x) = 2x^3 + 3x^2 + ax - 12$. When $\mathrm{p}(x)$ is divided by $x-1$ the remainder is b.

(i) Show that $a = -23$ and find the value of the constant b. [2]

(ii) Factorise $\mathrm{p}(x)$ completely and hence state all the solutions of $\mathrm{p}(x) = 0$. [4]

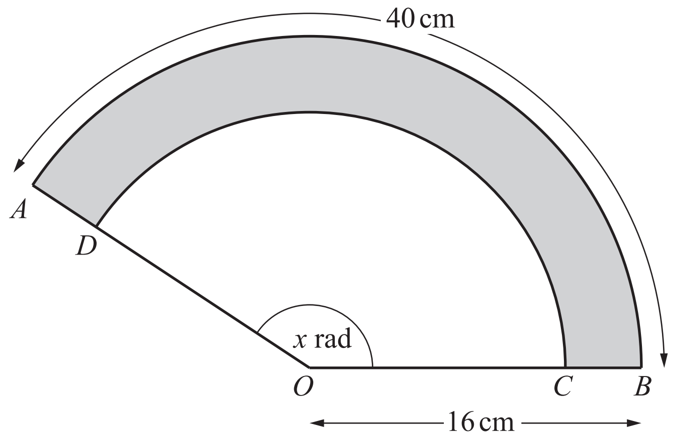
5 The function f is defined by $\mathrm{f}(x) = \dfrac{1}{2x - 5}$ for $x > 2.5$.

(i) Find an expression for $\mathrm{f}^{-1}(x)$. [2]

(ii) State the domain of $\mathrm{f}^{-1}(x)$. [1]

(iii) Find an expression for $\mathrm{f}^{2}(x)$, giving your answer in the form $\dfrac{ax+b}{cx+d}$, where a, b, c and d are integers to be found. [3]

6



In the diagram AOB and DOC are sectors of a circle centre O. The angle AOB is x radians. The length of the arc AB is 40 cm and the radius OB is 16 cm.

(i) Find the value of x. [2]

(ii) Find the area of sector AOB. [2]

(iii) Given that the area of the shaded region $ABCD$ is 140 cm^2, find the length of OC. [3]

7 Differentiate with respect to x

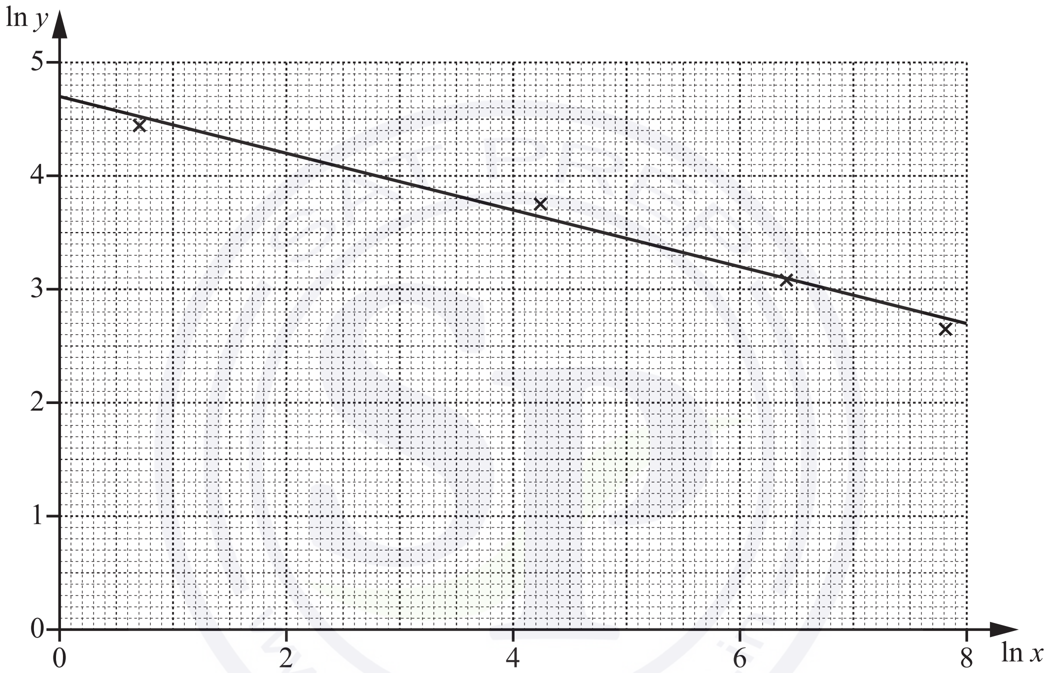
(i) $4x\tan x$, [2]

(ii) $\dfrac{e^{3x+1}}{x^2-1}$. [3]

8 An experiment was carried out recording values of y for certain values of x. The variables x and y are thought to be connected by the relationship $y = ax^n$, where a and n are constants.

(i) Transform the relationship $y = ax^n$ into straight line form. [2]

The values of $\ln y$ and $\ln x$ were plotted and a line of best fit drawn. This is shown in the diagram below.

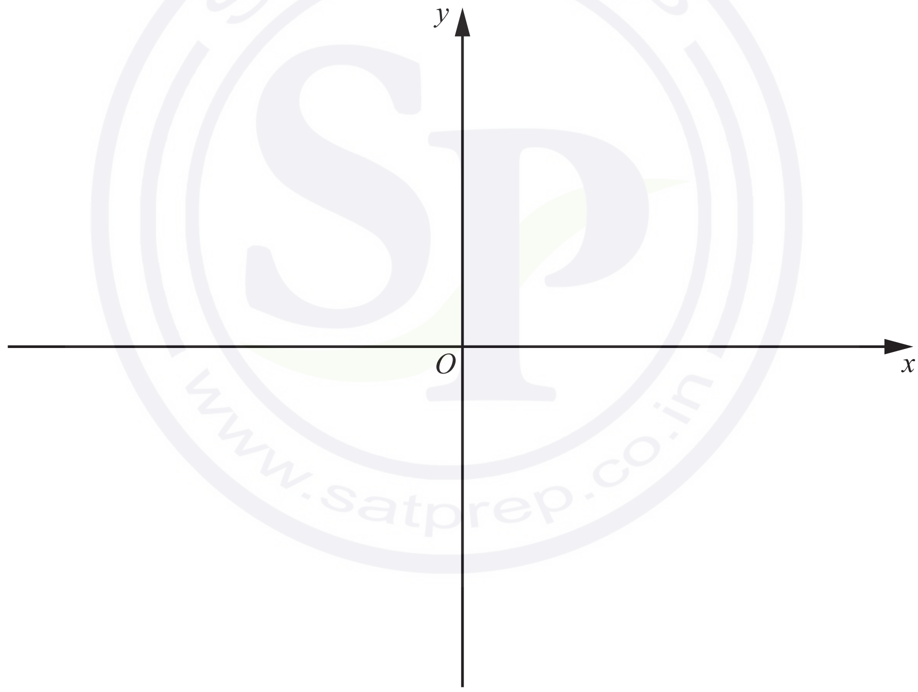


(ii) Use the graph to find the value of a and of n, stating the coordinates of the points that you use. [3]

(iii) Find the value of x when $y = 50$. [2]

9 **(i)** Express $5x^2 - 14x - 3$ in the form $p(x+q)^2 + r$, where p, q and r are constants. [3]

(ii) Sketch the graph of $y = \left|5x^2 - 14x - 3\right|$ on the axes below. Show clearly any points where your graph meets the coordinate axes. [4]



(iii) State the set of values of k for which $\left|5x^2 - 14x - 3\right| = k$ has exactly four solutions. [2]

10 A particle moves in a straight line such that its displacement, s metres, from a fixed point O at time t seconds, is given by $s = 4 + \cos 3t$, where $t \geqslant 0$. The particle is initially at rest.

(i) Find the exact value of t when the particle is next at rest. [2]

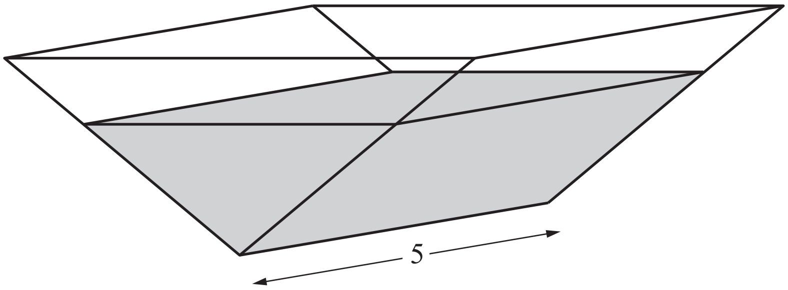
(ii) Find the distance travelled by the particle between $t = \frac{\pi}{4}$ and $t = \frac{\pi}{2}$ seconds. [3]

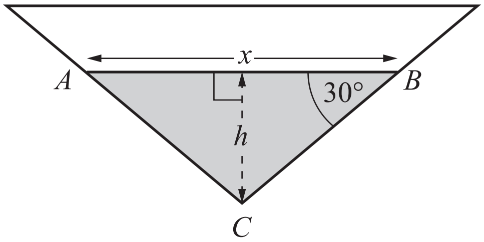
(iii) Find the greatest acceleration of the particle. [2]

11 **(a)** Solve $10\cos^2 x + 3\sin x = 9$ for $0° < x < 360°$. [5]

(b) Solve $3\tan 2y = 4\sin 2y$ for $0 < y < \pi$ radians. [5]

12 In this question all lengths are in metres.





A water container is in the shape of a triangular prism. The diagrams show the container and its cross-section. The cross-section of the water in the container is an isosceles triangle ABC, with angle ABC = angle BAC = 30°. The length of AB is x and the depth of water is h. The length of the container is 5.

(i) Show that $x = 2\sqrt{3}h$ and hence find the volume of water in the container in terms of h. [3]

(ii) The container is filled at a rate of $0.5\,\text{m}^3$ per minute. At the instant when h is $0.25\,\text{m}$, find

(a) the rate at which h is increasing, [4]

(b) the rate at which x is increasing. [2]

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4401850851

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2018**

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.
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You are reminded of the need for clear presentation in your answers.

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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 **15** printed pages and **1** blank page.

DC (KN/SW) 145515/2

CAMBRIDGE
International Examinations

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

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

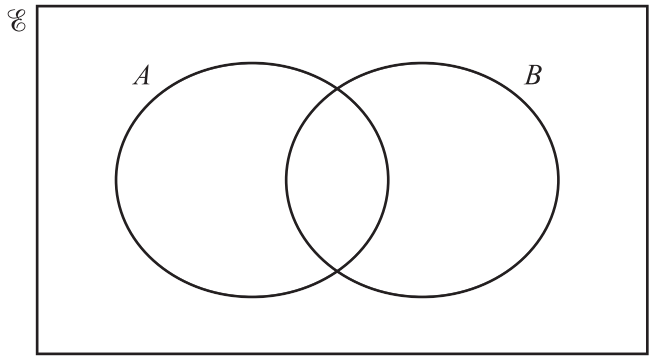
$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

1 **(i)** Show that $\cos\theta\cot\theta + \sin\theta = \operatorname{cosec}\theta$. [3]

(ii) Hence solve $\cos\theta\cot\theta + \sin\theta = 4$ for $0° \leqslant \theta \leqslant 90°$. [2]

2 **(a)** On the Venn diagram below, shade the region that represents $A \cap B'$.



[1]

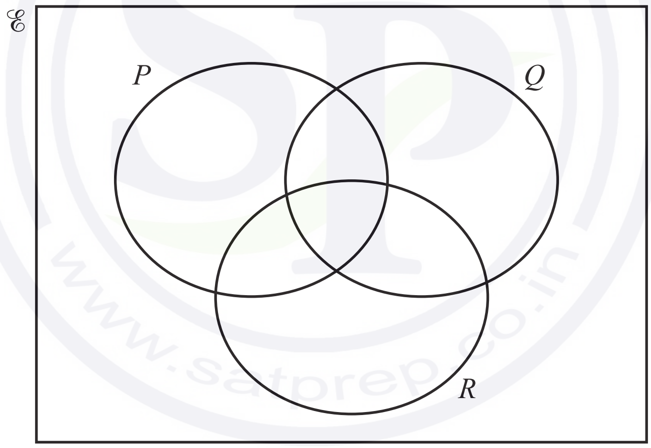
(b) The universal set ℰ and sets P, Q and R are such that

$(P \cup Q \cup R)' = \varnothing$, $P' \cap (Q \cap R) = \varnothing$,

$n(Q \cap R) = 8$, $n(P \cap R) = 8$, $n(P \cap Q) = 10$,

$n(P) = 21$, $n(Q) = 15$, $n(\mathscr{E}) = 30$.

Complete the Venn diagram to show this information and state the value of n(R).



n(R) = ... [4]

3 It is given that $x+3$ is a factor of the polynomial $\mathrm{p}(x) = 2x^3 + ax^2 - 24x + b$. The remainder when $\mathrm{p}(x)$ is divided by $x-2$ is -15. Find the remainder when $\mathrm{p}(x)$ is divided by $x+1$. [6]

4 Find the coordinates of the points where the line $2y - 3x = 6$ intersects the curve $\frac{x^2}{4} + \frac{y^2}{9} = 5$. [5]

5 **(a)** Four parts in a play are to be given to four of the girls chosen from the seven girls in a drama class. Find the number of different ways in which this can be done. [2]

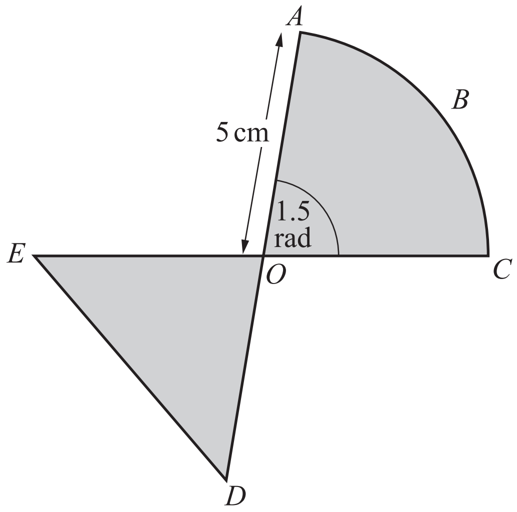
(b) Three singers are chosen at random from a group of 5 Chinese, 4 Indian and 2 British singers. Find the number of different ways in which this can be done if

(i) no Chinese singer is chosen, [1]

(ii) one singer of each nationality is chosen, [2]

(iii) the three singers chosen are all of the same nationality. [2]

6



In the diagram, *ABC* is an arc of the circle centre *O*, radius 5 cm, and angle *AOC* is 1.5 radians. *AD* and *CE* are diameters of the circle and *DE* is a straight line.

(i) Find the total perimeter of the shaded regions. [3]

(ii) Find the total area of the shaded regions. [3]

7 Vectors **i** and **j** are vectors parallel to the x-axis and y-axis respectively.

Given that $\mathbf{a} = 2\mathbf{i} + 3\mathbf{j}$, $\mathbf{b} = \mathbf{i} - 5\mathbf{j}$ and $\mathbf{c} = 3\mathbf{i} + 11\mathbf{j}$, find

(i) the exact value of $|\mathbf{a} + \mathbf{c}|$, [2]

(ii) the value of the constant m such that $\mathbf{a} + m\mathbf{b}$ is parallel to $\mathbf{j}$, [2]

(iii) the value of the constant n such that $n\mathbf{a} - \mathbf{b} = \mathbf{c}$. [2]

8 **(a)** $\mathbf{A} = \begin{pmatrix} 2 & -1 \\ 1 & -3 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 0 & -2 \\ 3 & -5 \end{pmatrix}$. Find $(\mathbf{BA})^{-1}$. [4]

(b) The matrix **X** is such that **XC** = **D**, where $\mathbf{C} = \begin{pmatrix} -2 & 5 & 3 \\ 0 & 10 & 4 \end{pmatrix}$ and $\mathbf{D} = \begin{pmatrix} -4 & 5 & 4 \end{pmatrix}$.

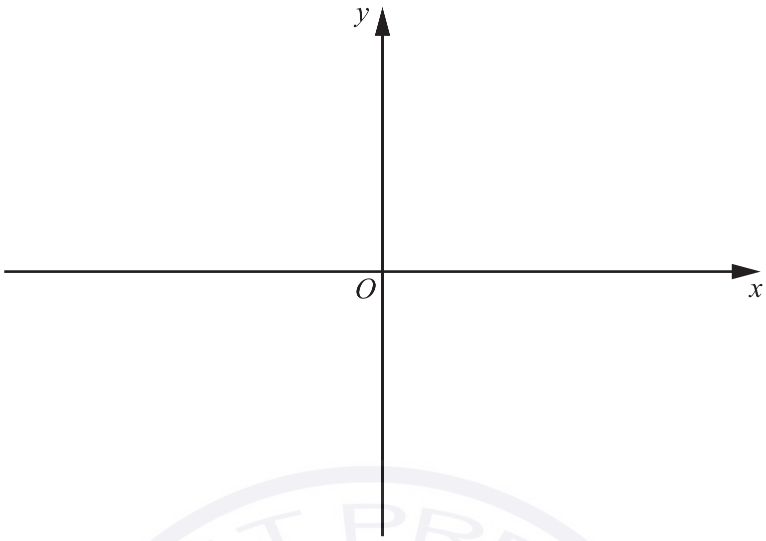
(i) State the order of the matrix **C**. [1]

(ii) Find the matrix **X**. [2]

9 **(i)** Differentiate $x^4(\sqrt{\sin x})$ with respect to x. [4]

(ii) Hence find $\int\left(x+\frac{x^4\cos x}{\sqrt{\sin x}}+8x^3(\sqrt{\sin x})\right)\mathrm{d}x$. [3]

10 **(a)** **(i)** On the axes below, sketch the graph of $y = |(x+3)(x-5)|$ showing the coordinates of the points where the curve meets the x-axis. [2]



(ii) Write down a suitable domain for the function $f(x) = |(x+3)(x-5)|$ such that f has an inverse. [1]

(b) The functions g and h are defined by

$$g(x) = 3x - 1 \quad \text{for } x > 1,$$
$$h(x) = \frac{4}{x} \quad \text{for } x \neq 0.$$

(i) Find $hg(x)$. [1]

(ii) Find $(hg)^{-1}(x)$. [2]

(c) Given that $p(a) = b$ and that the function p has an inverse, write down $p^{-1}(b)$. [1]

11 **(a)** Find $\int \sqrt[3]{2x-1}\,\mathrm{d}x$. [2]

(b) **(i)** Find $\int \sin 4x\,\mathrm{d}x$. [2]

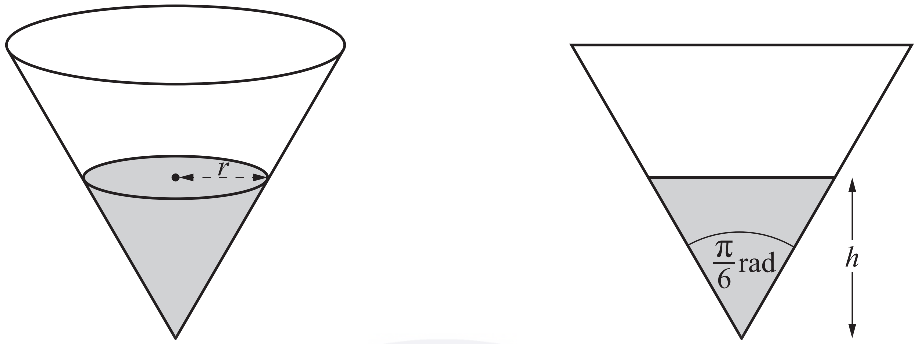
(ii) Hence evaluate $\int_{\frac{\pi}{8}}^{\frac{\pi}{4}} \sin 4x\,\mathrm{d}x$. [2]

(c) Show that $\int_0^{\ln 8} \mathrm{e}^{\frac{x}{3}}\,\mathrm{d}x = 3$. [5]

12 In this question all lengths are in centimetres.

The volume of a cone of height h and base radius r is given by $V = \frac{1}{3}\pi r^2 h$.

It is known that $\sin\frac{\pi}{12} = \frac{\sqrt{6}-\sqrt{2}}{4}$, $\cos\frac{\pi}{12} = \frac{\sqrt{6}+\sqrt{2}}{4}$, $\tan\frac{\pi}{12} = 2-\sqrt{3}$.



A water cup is in the shape of a cone with its axis vertical. The diagrams show the cup and its cross-section. The vertical angle of the cone is $\frac{\pi}{6}$ radians. The depth of water in the cup is h. The surface of the water is a circle of radius r.

(i) Find an expression for r in terms of h and show that the volume of water in the cup is given by $V = \frac{\pi(7-4\sqrt{3})h^3}{3}$. [4]

(ii) Water is poured into the cup at a rate of $30\,\text{cm}^3\,\text{s}^{-1}$. Find, correct to 2 decimal places, the rate at which the depth of water is increasing when $h = 5$. [4]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

5291701669

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2018**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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This document consists of **15** printed pages and **1** blank page.

DC (JM) 162865

CAMBRIDGE International Examinations

Mathematical Formulae

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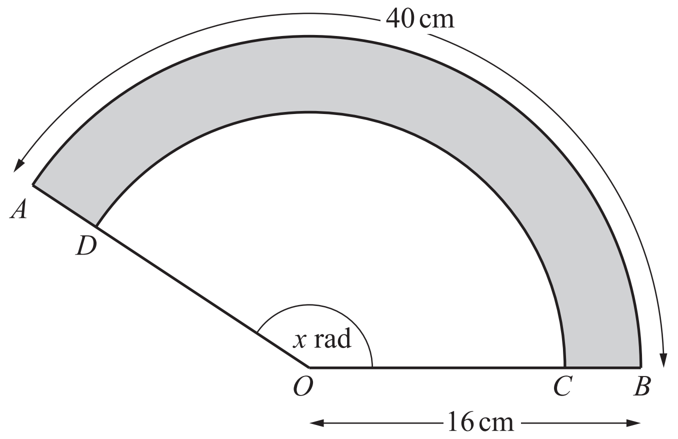
6



In the diagram AOB and DOC are sectors of a circle centre O. The angle AOB is x radians. The length of the arc AB is 40 cm and the radius OB is 16 cm.

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(ii) Find the area of sector AOB. [2]

(iii) Given that the area of the shaded region $ABCD$ is 140 cm^2, find the length of OC. [3]

7 Differentiate with respect to x

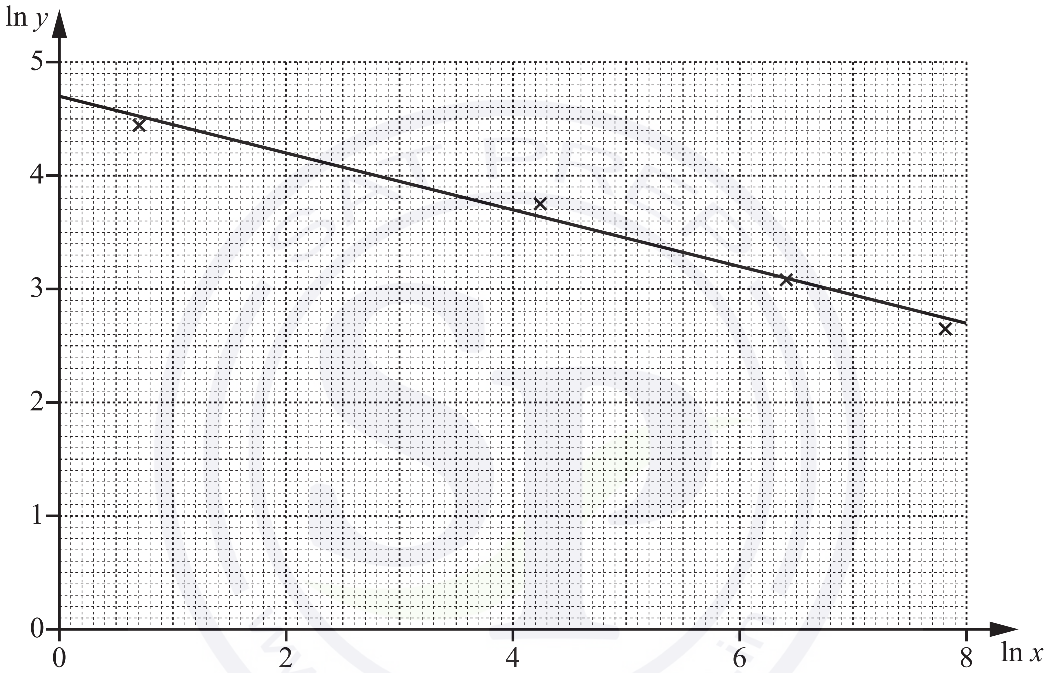
(i) $4x\tan x$, [2]

(ii) $\dfrac{e^{3x+1}}{x^2-1}$. [3]

8 An experiment was carried out recording values of y for certain values of x. The variables x and y are thought to be connected by the relationship $y = ax^n$, where a and n are constants.

(i) Transform the relationship $y = ax^n$ into straight line form. [2]

The values of $\ln y$ and $\ln x$ were plotted and a line of best fit drawn. This is shown in the diagram below.

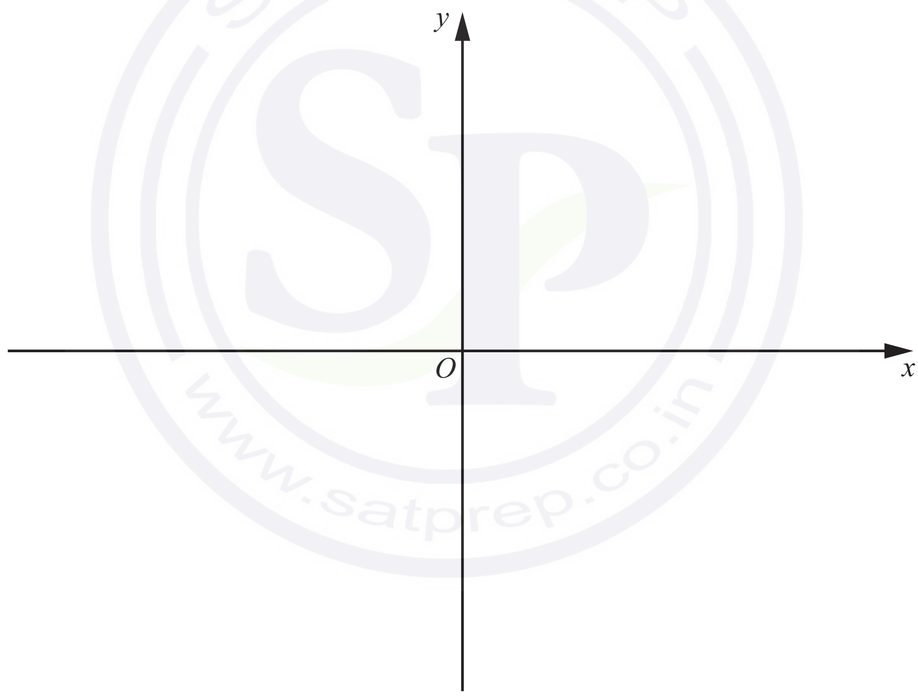


(ii) Use the graph to find the value of a and of n, stating the coordinates of the points that you use. [3]

(iii) Find the value of x when $y = 50$. [2]

9 **(i)** Express $5x^2 - 14x - 3$ in the form $p(x+q)^2 + r$, where p, q and r are constants. [3]

(ii) Sketch the graph of $y = \left|5x^2 - 14x - 3\right|$ on the axes below. Show clearly any points where your graph meets the coordinate axes. [4]



(iii) State the set of values of k for which $\left|5x^2 - 14x - 3\right| = k$ has exactly four solutions. [2]

10 A particle moves in a straight line such that its displacement, s metres, from a fixed point O at time t seconds, is given by $s = 4 + \cos 3t$, where $t \geqslant 0$. The particle is initially at rest.

(i) Find the exact value of t when the particle is next at rest. [2]

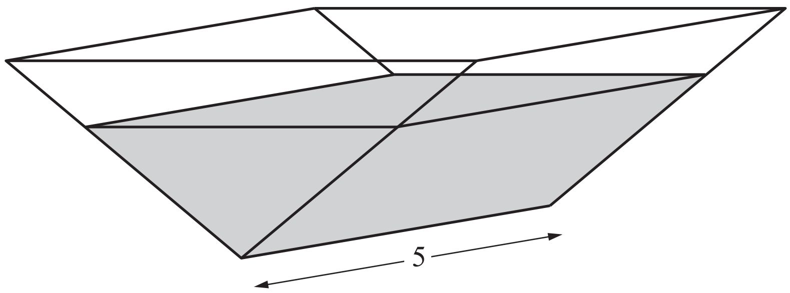
(ii) Find the distance travelled by the particle between $t = \frac{\pi}{4}$ and $t = \frac{\pi}{2}$ seconds. [3]

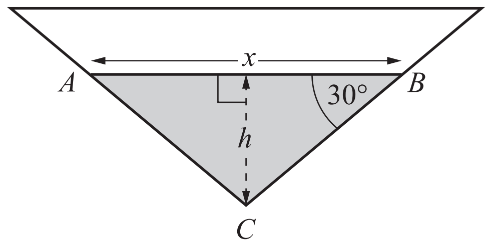
(iii) Find the greatest acceleration of the particle. [2]

11 **(a)** Solve $10\cos^2 x + 3\sin x = 9$ for $0° < x < 360°$. [5]

(b) Solve $3\tan 2y = 4\sin 2y$ for $0 < y < \pi$ radians. [5]

12 In this question all lengths are in metres.





A water container is in the shape of a triangular prism. The diagrams show the container and its cross-section. The cross-section of the water in the container is an isosceles triangle ABC, with angle ABC = angle BAC = 30°. The length of AB is x and the depth of water is h. The length of the container is 5.

(i) Show that $x = 2\sqrt{3}h$ and hence find the volume of water in the container in terms of h. [3]

(ii) The container is filled at a rate of $0.5\,\text{m}^3$ per minute. At the instant when h is $0.25\,\text{m}$, find

(a) the rate at which h is increasing, [4]

(b) the rate at which x is increasing. [2]

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4569060243

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **February/March 2018**

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.
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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 **14** printed pages and **2** blank pages.

DC (KN/CGW) 144842/2

CAMBRIDGE International Examinations

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

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

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

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

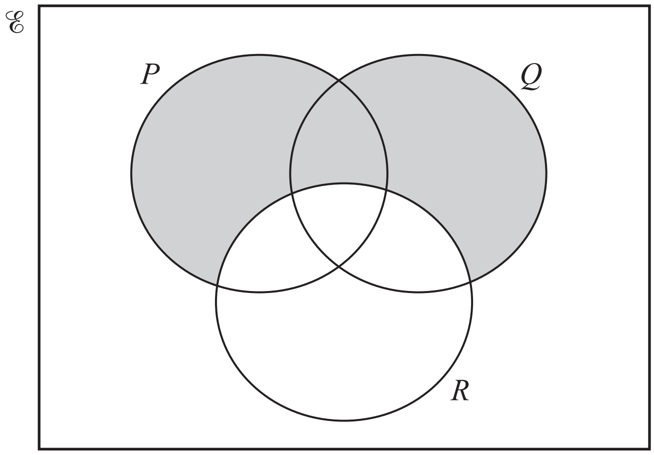
Formulae for ΔABC

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

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

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

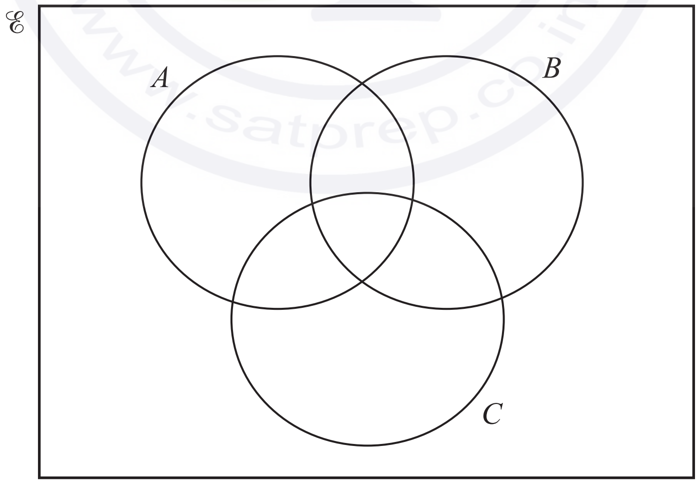
1 **(a)**



Using set notation, write down the set represented by the shaded region. [1]

(b) ℰ = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}
A = { x: x is a prime number}
B = { x: x is an even number}
C = {1, 2, 3, 4, 8}

(i) Complete the Venn diagram to show the elements of each set. [3]



(ii) Write down the value of $\text{n}((A \cup B \cup C)')$. [1]

2 Determine the set of values of k for which the equation $(3-2k)x^2+(2k-3)x+1=0$ has no real roots. [5]

3 A group of five people consists of two women, Alice and Betty, and three men, Carl, David and Ed.

(i) Three of these five people are chosen at random to be a chairperson, a treasurer and a secretary. Find the number of ways in which this can be done if the chairperson and treasurer are both men. [2]

These five people sit in a row of five chairs. Find the number of different possible seating arrangements if

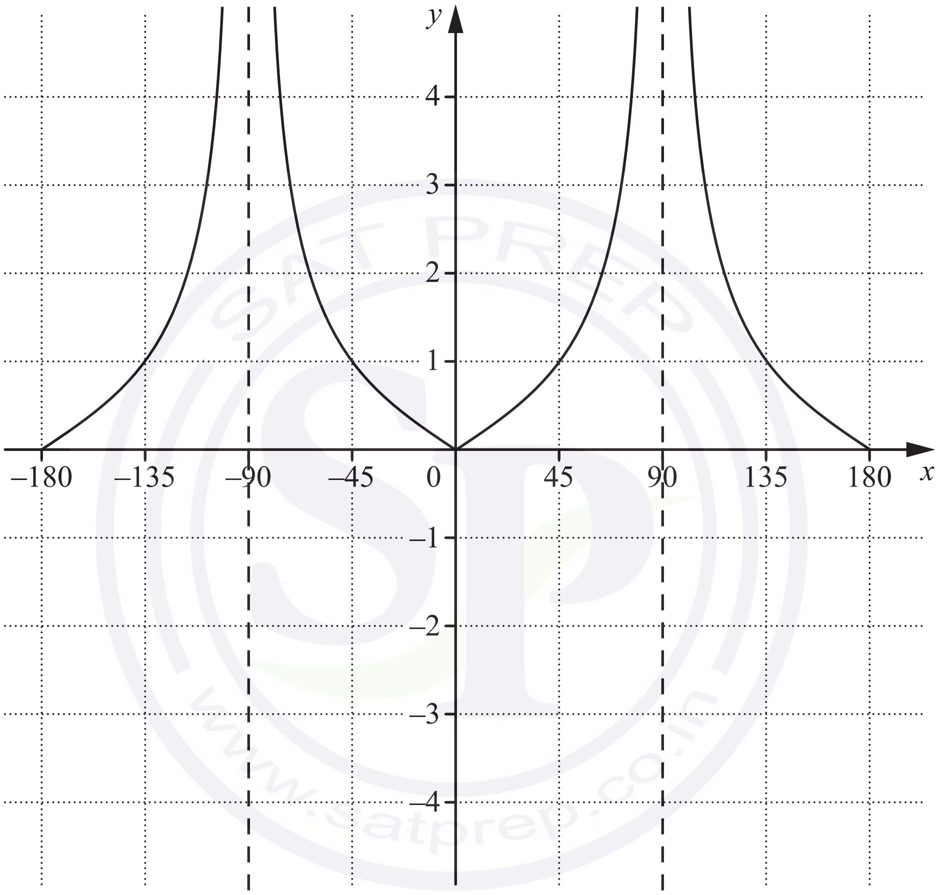
(ii) David must sit in the middle, [1]

(iii) Alice and Carl must sit together. [2]

4 **(a)** **(i)** State the amplitude of $15\sin 2x - 5$. [1]

(ii) State the period of $15\sin 2x - 5$. [1]

(b)

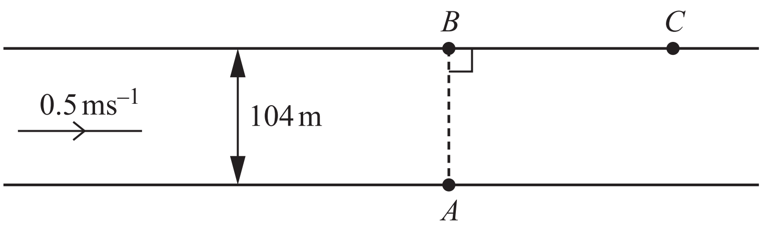


The diagram shows the graph of $y = |f(x)|$ for $-180^\circ \leqslant x^\circ \leqslant 180^\circ$, where $f(x)$ is a trigonometric function.

(i) Write down two possible expressions for the trigonometric function $f(x)$. [2]

(ii) State the number of solutions of the equation $|f(x)| = 1$ for $-180^\circ \leqslant x^\circ \leqslant 180^\circ$. [1]

5

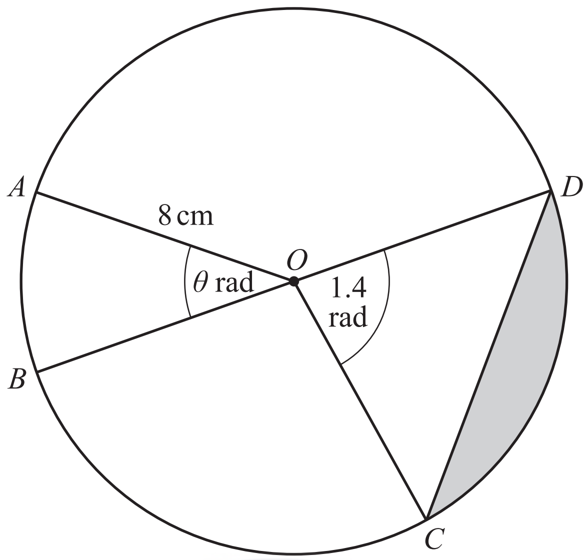


A river is 104 metres wide and the current flows at $0.5\,\text{ms}^{-1}$ parallel to its banks. A woman can swim at $1.6\,\text{ms}^{-1}$ in still water. She swims from point A and aims for point B which is directly opposite, but she is carried downstream to point C. Calculate the time it takes the woman to swim across the river and the distance downstream, BC, that she travels. [4]

6 **(i)** Differentiate $1 + \tan\left(\frac{x}{3}\right)$ with respect to x. [2]

(ii) Hence find $\int \sec^2\left(\frac{x}{3}\right)\mathrm{d}x$. [2]

7



The diagram shows a circle with centre O and radius 8 cm. The points A, B, C and D lie on the circumference of the circle. Angle $AOB = \theta$ radians and angle $COD = 1.4$ radians. The area of sector AOB is $20\,\text{cm}^2$.

(i) Find angle θ. [2]

(ii) Find the length of the arc AB. [2]

(iii) Find the area of the shaded segment. [3]

8 **(a)** Solve the following equations.

(i) $5e^{3x+4} = 14$ [2]

(ii) $\lg(2y - 7) + \lg y = 2\lg 3$ [4]

(b) Write $\dfrac{\log_2 p - \log_2 q}{(\log_2 r)(\log_r 2)}$ as a single logarithm to base 2. [2]

9 **Solutions to this question by accurate drawing will not be accepted.**

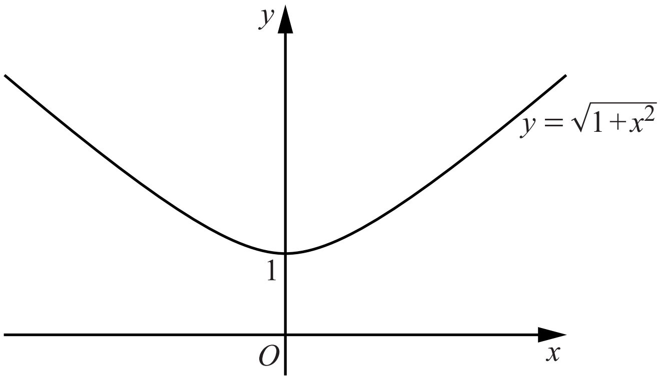
P is the point (8, 2) and Q is the point (11, 6).

(i) Find the equation of the line L which passes through P and is perpendicular to the line PQ. [3]

The point R lies on L such that the area of triangle PQR is 12.5 units^2.

(ii) Showing all your working, find the coordinates of each of the two possible positions of point R. [6]

10 **(a)** The function f is defined by $f(x) = \sqrt{1 + x^2}$, for all real values of x. The graph of $y = f(x)$ is given below.



(i) Explain, with reference to the graph, why f does not have an inverse. [1]

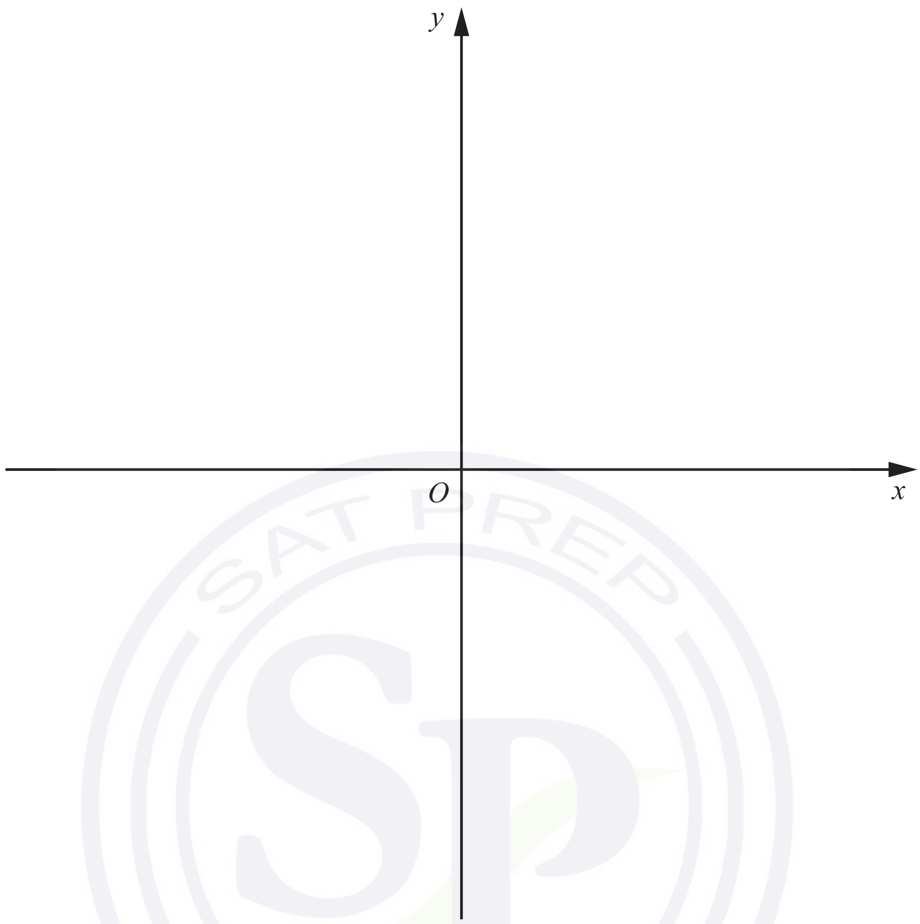
(ii) Find $f^2(x)$. [2]

(b) The function g is defined, for $x > k$, by $g(x) = \sqrt{1 + x^2}$ and g has an inverse.

(i) Write down a possible value for k. [1]

(ii) Find $g^{-1}(x)$. [2]

(c) The function h is defined, for all real values of x, by $h(x) = 4e^x + 2$. Sketch the graph of $y = h(x)$. Hence, on the same axes, sketch the graph of $y = h^{-1}(x)$. Give the coordinates of any points where your graphs meet the coordinate axes. [4]



11 **(a)** **(i)** Show that $\dfrac{(1-\sin A)(1+\sin A)}{\sin A\cos A} = \cot A$. [2]

(ii) Hence solve $\dfrac{(1-\sin 3x)(1+\sin 3x)}{\sin 3x\cos 3x} = \dfrac{1}{2}$ for $0° \leqslant x \leqslant 180°$. [4]

(b) Solve $10\tan^2 y - \sec y - 1 = 0$ for $0 \leqslant y \leqslant 2\pi$ radians. [5]

12 The volume, V, and surface area, S, of a sphere of radius r are given by $V = \frac{4}{3}\pi r^3$ and $S = 4\pi r^2$ respectively.

The volume of a sphere increases at a rate of $200\,\text{cm}^3$ per second. At the instant when the radius of the sphere is $10\,\text{cm}$, find

(i) the rate of increase of the radius of the sphere, [4]

(ii) the rate of increase of the surface area of the sphere. [3]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

Cambridge IGCSE

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

7690408726

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2017**

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.
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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.

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CAMBRIDGE
International Examinations

[Turn over

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

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

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

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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 Solve the inequality $(x-1)(x-5) > 12$. [4]

2 Show that $\frac{1}{1-\sin\theta} - \frac{1}{1+\sin\theta} = 2\tan\theta\sec\theta$. [4]

3 Solve the equation $\log_5(10x + 5) = 2 + \log_5(x - 7)$. [4]

4 Solve the following simultaneous equations for x and y, giving each answer in its simplest surd form.

$$\sqrt{3}x + y = 4$$

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

[5]

5 **(i)** Find $\frac{d}{dx}\left(\frac{5}{3x+2}\right)$. [2]

(ii) Use your answer to part **(i)** to find $\int \frac{30}{(3x+2)^2}\,dx$. [2]

(iii) Hence evaluate $\int_1^2 \frac{30}{(3x+2)^2}\,dx$. [2]

6 It is given that $\mathbf{M} = \begin{pmatrix} 2 & p \\ -3 & q \end{pmatrix}$ where p and q are integers.

(i) If det $\mathbf{M} = 13$, find an equation connecting p and q. [1]

(ii) Given also that $\mathbf{M}^2 = \begin{pmatrix} 4-3p & 12 \\ -6-3q & -3p+q^2 \end{pmatrix}$, find a second equation connecting p and q. [2]

(iii) Find the value of p and of q. [4]

7 Find y in terms of x, given that $\frac{d^2y}{dx^2} = 6x + \frac{2}{x^3}$ and that when $x = 1$, $y = 3$ and $\frac{dy}{dx} = 1$. [6]

8 Given that $z = a + (a+3)\sqrt{3}$ and $z^2 = 79 + b\sqrt{3}$, find the value of each of the integers a and b. [6]

9 **(i)** Expand $(1 + x)^4$, simplifying all coefficients. [1]

(ii) Expand $(6 - x)^4$, simplifying all coefficients. [2]

(iii) Hence express $(6 - x)^4 - (1 + x)^4 = 175$ in the form $ax^3 + bx^2 + cx + d = 0$, where a, b, c and d are integers. [2]

(iv) Show that $x = 2$ is a solution of the equation in part **(iii)** and show that this equation has no other real roots. [5]

10 In this question $\mathbf{i}$ is a unit vector due east and $\mathbf{j}$ is a unit vector due north. Units of length and velocity are metres and metres per second respectively.

The initial position vectors of particles A and B, relative to a fixed point O, are $2\mathbf{i} + 4\mathbf{j}$ and $10\mathbf{i} + 14\mathbf{j}$ respectively. Particles A and B start moving at the same time. A moves with constant velocity $\mathbf{i} + \mathbf{j}$ and B moves with constant velocity $-2\mathbf{i} - 3\mathbf{j}$. Find

(i) the position vector of A after t seconds, [1]

(ii) the position vector of B after t seconds. [1]

It is given that X is the distance between A and B after t seconds.

(iii) Show that $X^2 = (8 - 3t)^2 + (10 - 4t)^2$. [3]

(iv) Find the value of t for which $(8 - 3t)^2 + (10 - 4t)^2$ has a stationary value and the corresponding value of X. [4]

11 The line $y = kx + 3$, where k is a positive constant, is a tangent to the curve $x^2 - 2x + y^2 = 8$ at the point P.

(i) Find the value of k. [4]

(ii) Find the coordinates of P. [3]

(iii) Find the equation of the normal to the curve at P. [2]

12 **(i)** Differentiate $(\cos x)^{-1}$ with respect to x. [2]

(ii) Hence find $\frac{\mathrm{d}y}{\mathrm{d}x}$ given that $y = \tan x + 4(\cos x)^{-1}$. [2]

(iii) Using your answer to part **(ii)** find the values of x in the range $0 \leqslant x \leqslant 2\pi$ such that $\frac{\mathrm{d}y}{\mathrm{d}x} = 4$. [6]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

8047669716

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **October/November 2017**

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.
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CAMBRIDGE International Examinations

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

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

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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 If $z = 2 + \sqrt{3}$ find the integers a and b such that $az^2 + bz = 1 + \sqrt{3}$. [5]

2 Solve the equation $\dfrac{2x^{1.5} + 6x^{-0.5}}{x^{0.5} + 5x^{-0.5}} = x$. [5]

3 Solve the inequality $|3x - 1| > 3 + x$. [3]

4 Solve the simultaneous equations

$$\log_2(x+4) = 2\log_2 y,$$

$$\log_2(7y - x) = 4.$$

[5]

5 Naomi is going on holiday and intends to read 4 books during her time away. She selects these books from 5 mystery, 3 crime and 2 romance books. Find the number of ways in which she can make her selection in each of the following cases.

(i) There are no restrictions. [1]

(ii) She selects at least 2 mystery books. [3]

(iii) She selects at least 1 book of each type. [3]

6 The volume of a closed cylinder of base radius x cm and height h cm is $500\,\text{cm}^3$.

(i) Express h in terms of x. [1]

(ii) Show that the total surface area of the cylinder is given by $A = 2\pi x^2 + \dfrac{1000}{x}\,\text{cm}^2$. [2]

(iii) Given that x can vary, find the stationary value of A and show that this value is a minimum. [5]

7 The gradient of the normal to a curve at the point with coordinates (x, y) is given by $\frac{\sqrt{x}}{1-3x}$.

(i) Find the equation of the curve, given that the curve passes through the point $(1, -10)$. [5]

(ii) Find, in the form $y = mx + c$, the equation of the tangent to the curve at the point where $x = 4$. [4]

8 The matrix **A** is $\begin{pmatrix} 2 & 1 \\ 4 & 3 \end{pmatrix}$.

(i) Find $(2\mathbf{A})^{-1}$. [3]

(ii) Hence solve the simultaneous equations

$$2y + 4x + 5 = 0,$$

$$6y + 8x + 9 = 0.$$

[4]

9 **(i)** Find $\frac{d}{dx}(x \ln x)$. [2]

(ii) Hence find $\int \ln x \, dx$. [2]

(iii) Hence, given that $k > 0$, show that $\int_{k}^{2k} \ln x \, dx = k(\ln 4k - 1)$. [4]

10 **(i)** **Without using a calculator**, solve the equation $6c^3 - 7c^2 + 1 = 0$. [5]

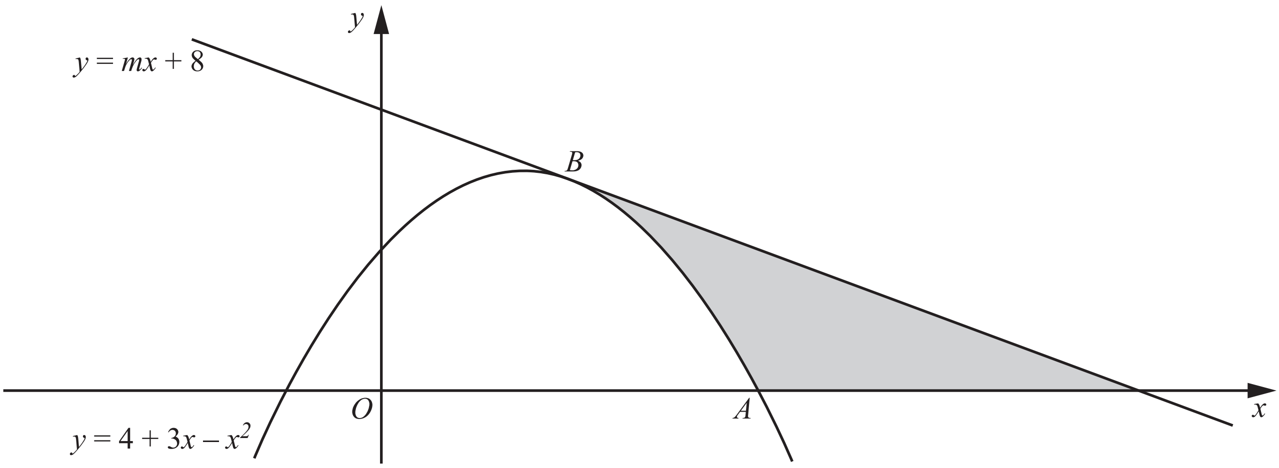
It is given that $y = \tan x + 6\sin x$.

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

(iii) If $\frac{\mathrm{d}y}{\mathrm{d}x} = 7$ show that $6\cos^3 x - 7\cos^2 x + 1 = 0$. [2]

(iv) Hence solve the equation $\frac{\mathrm{d}y}{\mathrm{d}x} = 7$ for $0 \leqslant x \leqslant \pi$ radians. [2]

11



The diagram shows the curve $y = 4 + 3x - x^2$ intersecting the positive x-axis at the point A. The line $y = mx + 8$ is a tangent to the curve at the point B. Find

(i) the coordinates of A, [2]

(ii) the value of m, [3]

(iii) the coordinates of B, [2]

(iv) the area of the shaded region, showing all your working. [5]

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER

7407739830

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2017**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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The total number of marks for this paper is 80.

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

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CAMBRIDGE
International Examinations

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Mathematical Formulae

1. ALGEBRA

Quadratic Equation

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

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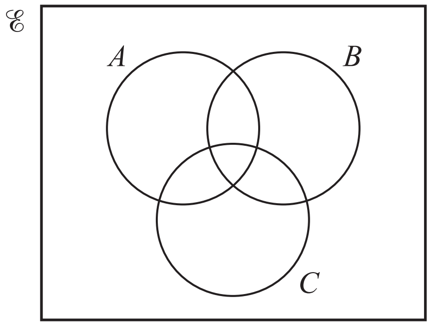
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

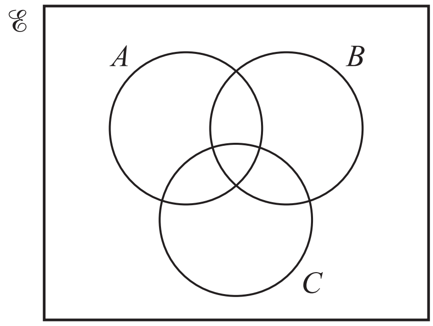
$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

1 **(a)** On each of the diagrams below, shade the region which represents the given set.



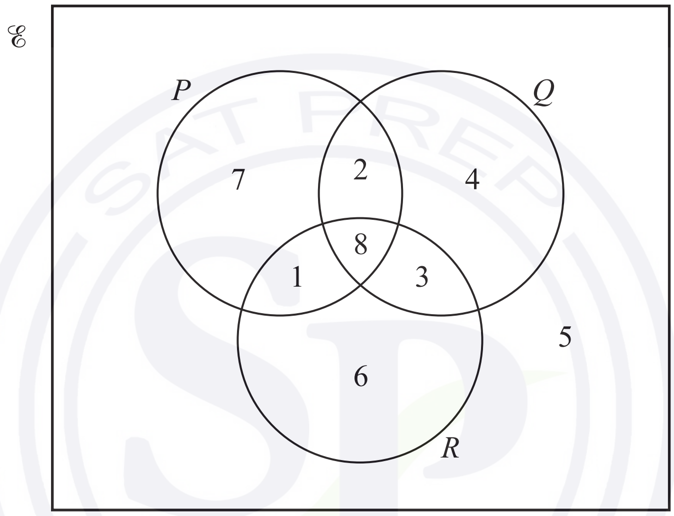
$(A \cup B) \cap C'$



$(A \cap B') \cup C$

[2]

(b)



The Venn diagram shows the number of elements in each of its subsets.

Complete the following.

$n(P') =$ ....

$n((Q \cup R) \cap P) =$ ....

$n(Q' \cup P) =$ .... [3]

2 Solve the equation $|3x-1|=|5+x|$. [3]

3 Find integers p and q such that $\dfrac{p}{\sqrt{3}-1}+\dfrac{1}{\sqrt{3}+1}=q+3\sqrt{3}$. [4]

4 Solve the simultaneous equations

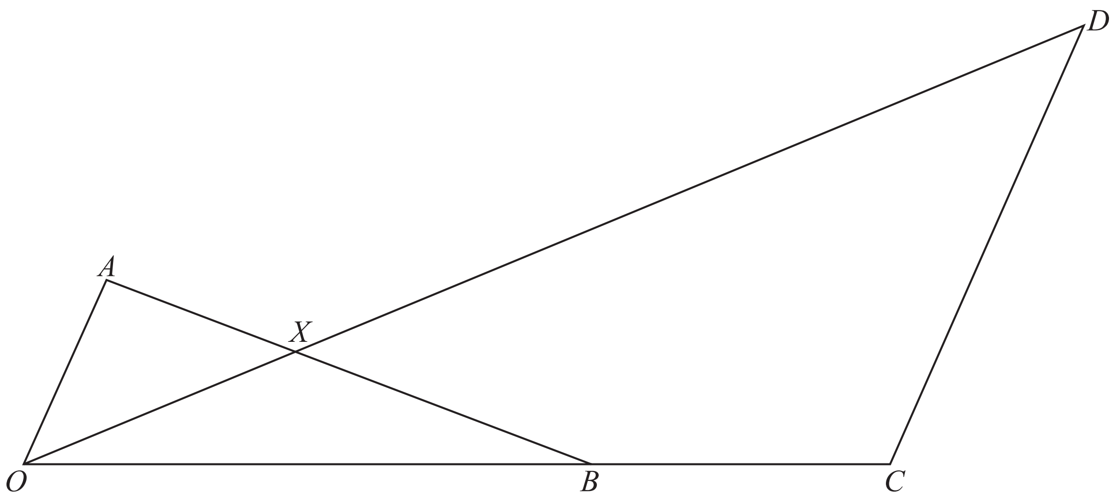
$$\log_3(x+1) = 1 + \log_3 y,$$

$$\log_3(x-y) = 2.$$

[5]

  [Turn over

5



The diagram shows points O, A, B, C, D and X. The position vectors of A, B and C relative to O are $\overrightarrow{OA} = \mathbf{a}$, $\overrightarrow{OB} = \mathbf{b}$ and $\overrightarrow{OC} = \frac{3}{2}\mathbf{b}$. The vector $\overrightarrow{CD} = 3\mathbf{a}$.

(i) If $\overrightarrow{OX} = \lambda\overrightarrow{OD}$ express $\overrightarrow{OX}$ in terms of λ, $\mathbf{a}$ and $\mathbf{b}$. [1]

(ii) If $\overrightarrow{AX} = \mu\overrightarrow{AB}$ express $\overrightarrow{OX}$ in terms of μ, $\mathbf{a}$ and $\mathbf{b}$. [2]

(iii) Use your two expressions for $\overrightarrow{OX}$ to find the value of λ and of μ. [3]

(iv) Find the ratio $\frac{AX}{XB}$. [1]

(v) Find the ratio $\frac{OX}{XD}$. [1]

6 The functions f and g are defined for real values of x by

$$f(x) = (x+2)^2 + 1,$$

$$g(x) = \frac{x-2}{2x-1},\ x \neq \frac{1}{2}.$$

(i) Find $f^2(-3)$. [2]

(ii) Show that $g^{-1}(x) = g(x)$. [3]

(iii) Solve $gf(x) = \frac{8}{19}$. [4]

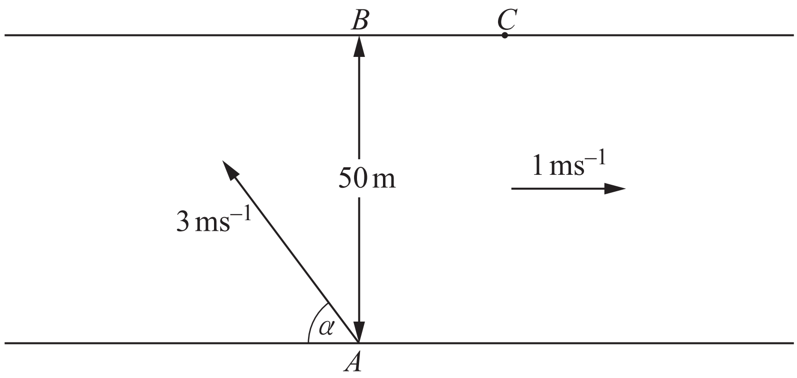
7 A particle moving in a straight line passes through a fixed point O. Its velocity, v ms^{-1}, t s after passing through O, is given by $v = 3\cos 2t - 1$ for $t \geqslant 0$.

(i) Find the value of t when the particle is first at rest. [2]

(ii) Find the displacement from O of the particle when $t = \frac{\pi}{4}$. [3]

(iii) Find the acceleration of the particle when it is first at rest. [3]

8



A man, who can row a boat at $3\,\text{ms}^{-1}$ in still water, wants to cross a river from A to B as shown in the diagram. AB is perpendicular to both banks of the river. The river, which is 50 m wide, is flowing at $1\,\text{ms}^{-1}$ in the direction shown. The man points his boat at an angle $\alpha°$ to the bank. Find

(i) the angle α, [2]

(ii) the resultant speed of the boat from A to B, [2]

(iii) the time taken for the boat to travel from A to B. [2]

On another occasion the man points the boat in the same direction but the river speed has increased to $1.8\,\text{ms}^{-1}$ and as a result he lands at the point C.

(iv) State the time taken for the boat to travel from A to C and hence find the distance BC. [2]

9 **(i)** Show that $\frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{\ln x}{x^3}\right) = \frac{1 - 3\ln x}{x^4}$. [3]

(ii) Find the exact coordinates of the stationary point of the curve $y = \frac{\ln x}{x^3}$. [3]

(iii) Use the result from part **(i)** to find $\int\left(\frac{\ln x}{x^4}\right)\mathrm{d}x$. [4]

10 **(a)** Show that $\dfrac{\sin x}{1+\cos x}+\dfrac{1+\cos x}{\sin x}=2\operatorname{cosec} x$. [3]

(b) Solve the following equations.

(i) $\cot^2 y+\operatorname{cosec} y-5=0$ for $0^\circ \leqslant y \leqslant 360^\circ$ [5]

(ii) $\cos\left(2z+\frac{\pi}{4}\right)=-\frac{\sqrt{3}}{2}$ for $0 \leqslant z \leqslant \pi$ radians [4]

Question 11 is printed on the next page.

11 The cubic equation $x^3 + ax^2 + bx - 36 = 0$ has a repeated positive integer root.

(i) If the repeated root is $x = 3$ find the other positive root and the value of a and of b. [4]

(ii) There are other possible values of a and b for which the cubic equation has a repeated positive integer root. In each case state all three integer roots of the equation. [4]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6595404132

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2017**

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 **12** printed pages.

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[Turn over

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 Find the equation of the curve which passes through the point (2, 17) and for which $\frac{dy}{dx} = 4x^3 + 1$. [4]

2 **Do not use a calculator in this question.**

(a) Show that $\sqrt{24} \times \sqrt{27} + \frac{9\sqrt{30}}{\sqrt{15}}$ can be written in the form $a\sqrt{2}$, where a is an integer. [3]

(b) Solve the equation $\sqrt{3}(1 + x) = 2(x - 3)$, giving your answer in the form $b + c\sqrt{3}$, where b and c are integers. [3]

3 The variables x and y are such that $y = \ln(x^2 + 1)$.

(i) Find an expression for $\frac{dy}{dx}$. [2]

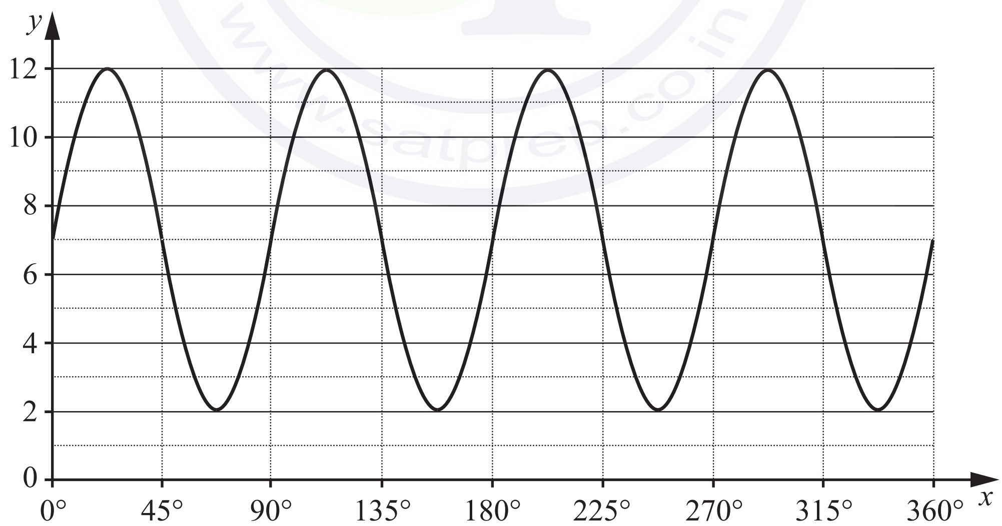
(ii) Hence, find the approximate change in y when x increases from 3 to $3 + h$, where h is small. [2]

4 **(a)** Given that $y = 7\cos 10x - 3$, where the angle x is measured in degrees, state

(i) the period of y, [1]

(ii) the amplitude of y. [1]

(b)



Find the equation of the curve shown, in the form $y = a\mathrm{g}(bx) + c$, where $\mathrm{g}(x)$ is a trigonometric function and a, b and c are integers to be found. [4]

5 **(i)** Given that a is a constant, expand $(2 + ax)^4$, in ascending powers of x, simplifying each term of your expansion. [2]

Given also that the coefficient of x^2 is equal to the coefficient of x^3,

(ii) show that $a = 3$, [1]

(iii) use your expansion to show that the value of 1.97^4 is 15.1 to 1 decimal place. [2]

6 Four cinemas, P, Q, R and S each sell adult, student and child tickets. The number of tickets sold by each cinema on one weekday were

P: 90 adult, 10 student, 30 child
Q: 45 student
R: 25 adult, 15 child
S: 10 adult, 100 child.

(i) Given that $\mathbf{L} = (1 \quad 1 \quad 1 \quad 1)$, construct a matrix, **M**, of the number of tickets sold, such that the matrix product **LM** can be found. [1]

(ii) Find the matrix product **LM**. [1]

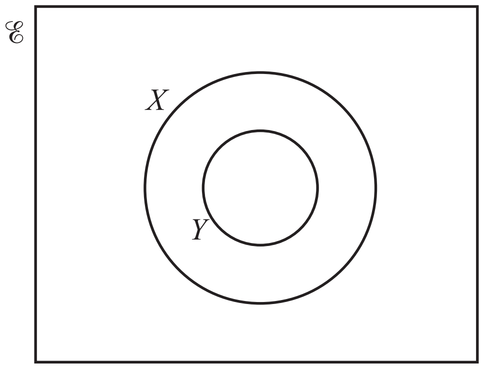
(iii) State what information is represented by the matrix product **LM**. [1]

An adult ticket costs \$5, a student ticket costs \$4 and a child ticket costs \$3.

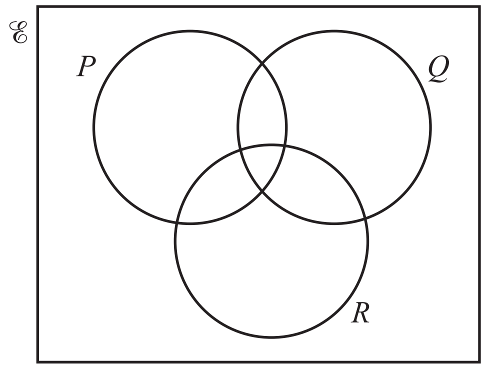
(iv) Construct a matrix, **N**, of the ticket costs, such that the matrix product **LMN** can be found and state what information is represented by the matrix product **LMN**. [2]

7 **(a)** On each of the Venn diagrams below shade the region which represents the given set.

$X \cap Y'$



$P' \cap Q \cap R$



[2]

(b) In a group of students, each student studies at most two of art, music and design. No student studies both music and design.

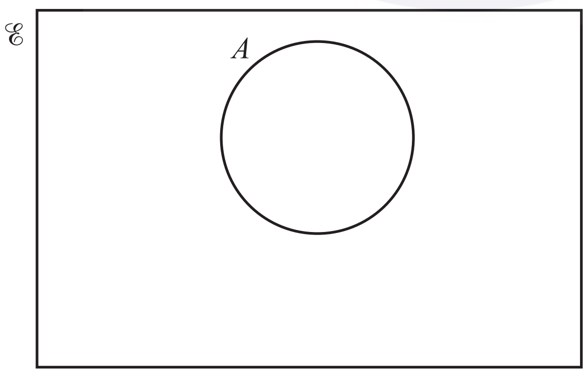
A denotes the set of students who study art,
M denotes the set of students who study music,
D denotes the set of students who study design.

(i) Write the following using set notation.

No student studies both music and design. [1]

There are 100 students in the group. 39 students study art, 45 study music and 36 study design. 12 students study both art and music. 25 students study both art and design.

(ii) Complete the Venn diagram below to represent this information and hence find the number of students in the group who do not study any of these subjects.



[3]

8 **(a)** A football club has 30 players. In how many different ways can a captain and a vice-captain be selected at random from these players? [1]

(b) A team of 11 teachers is to be chosen from 2 mathematics teachers, 5 computing teachers and 9 science teachers. Find the number of different teams that can be chosen if

(i) the team must have exactly 1 mathematics teacher, [2]

(ii) the team must have exactly 1 mathematics teacher and at least 4 computing teachers. [4]

9 The curve $3x^2 + xy - y^2 + 4y - 3 = 0$ and the line $y = 2(1 - x)$ intersect at the points A and B.

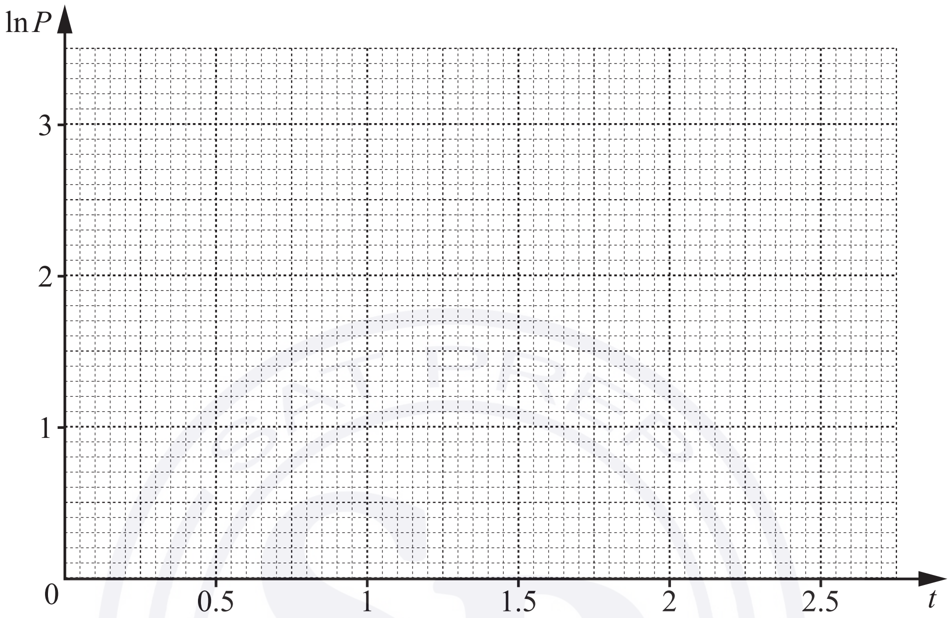
(i) Find the coordinates of A and of B. [5]

(ii) Find the equation of the perpendicular bisector of the line AB, giving your answer in the form $ax + by = c$, where a, b and c are integers. [4]

10 The table shows values of the variables t and P.

t	1	1.5	2	2.5
P	4.39	8.33	15.8	30.0

(i) Draw the graph of $\ln P$ against t on the grid below. [2]



(ii) Use the graph to estimate the value of P when $t = 2.2$. [2]

(iii) Find the gradient of the graph and state the coordinates of the point where the graph meets the vertical axis. [2]

(iv) Using your answers to part **(iii)**, show that $P = ab^t$, where a and b are constants to be found. [3]

(v) Given that your equation in part **(iv)** is valid for values of t up to 10, find the smallest value of t, correct to 1 decimal place, for which P is at least 1000. [2]

11 **(i)** Prove that $\sin x(\cot x + \tan x) = \sec x$. [4]

(ii) Hence solve the equation $|\sin x(\cot x + \tan x)| = 2$ for $0° \leqslant x \leqslant 360°$. [4]

Question 12 is printed on the next page.

12 A particle moves in a straight line so that, t seconds after passing a fixed point O, its displacement, s m, from O is given by

$$s = 1 + 3t - \cos 5t.$$

(i) Find the distance between the particle's first two positions of instantaneous rest. [7]

(ii) Find the acceleration when $t = \pi$. [2]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8715880044

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2017**

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.
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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.

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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 Solve $|5x+3| = |1-3x|$. [3]

2 **Without using a calculator**, express $\left(\dfrac{1+\sqrt{5}}{3-\sqrt{5}}\right)^{-2}$ in the form $a+b\sqrt{5}$, where a and b are integers. [5]

3 **Without using a calculator**, factorise the expression $10x^3 - 21x^2 + 4$. [5]

4 The point P lies on the curve $y = 3x^2 - 7x + 11$. The normal to the curve at P has equation $5y + x = k$. Find the coordinates of P and the value of k. [6]

5 **(i)** Show that $\frac{\mathrm{d}}{\mathrm{d}x}[0.4x^5(0.2 - \ln 5x)] = kx^4 \ln 5x$, where k is an integer to be found. [2]

(ii) Express $\ln 125x^3$ in terms of $\ln 5x$. [1]

(iii) Hence find $\int (x^4 \ln 125x^3)\,\mathrm{d}x$. [2]

6 Show that the roots of $px^2 + (p - q)x - q = 0$ are real for all real values of p and q. [4]

7 **(a)** Given that $a^7 = b$, where a and b are positive constants, find,

(i) $\log_a b$, [1]

(ii) $\log_b a$. [1]

(b) Solve the equation $\log_{81} y = -\frac{1}{4}$. [2]

(c) Solve the equation $\frac{32^{x^2-1}}{4^{x^2}} = 16$. [3]

8 Solutions to this question by accurate drawing will not be accepted.

The points A and B are $(-8, 8)$ and $(4, 0)$ respectively.

(i) Find the equation of the line AB. [2]

(ii) Calculate the length of AB. [2]

The point C is $(0, 7)$ and D is the mid-point of AB.

(iii) Show that angle ADC is a right angle. [3]

The point E is such that $\overrightarrow{AE} = \begin{pmatrix} 4 \\ -7 \end{pmatrix}$.

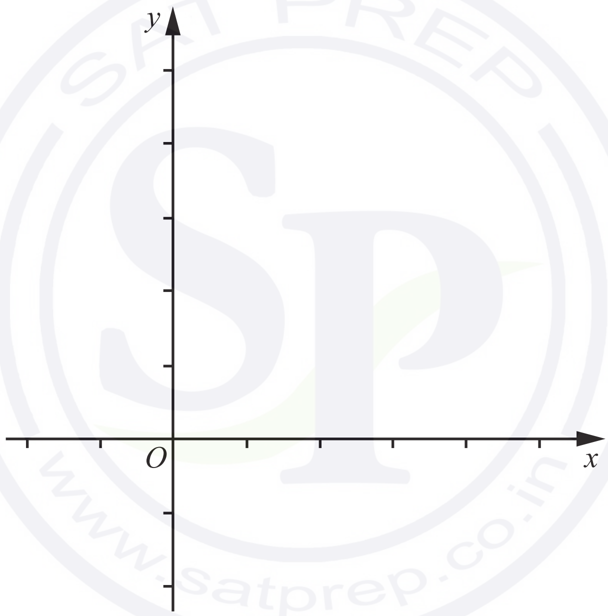
(iv) Write down the position vector of the point E. [1]

(v) Show that $ACBE$ is a parallelogram. [2]

9 A function f is defined, for $x \leqslant \frac{3}{2}$, by $\quad f(x) = 2x^2 - 6x + 5$.

(i) Express $f(x)$ in the form $a(x-b)^2 + c$, where a, b and c are constants. [3]

(ii) On the same axes, sketch the graphs of $y = f(x)$ and $y = f^{-1}(x)$, showing the geometrical relationship between them. [3]



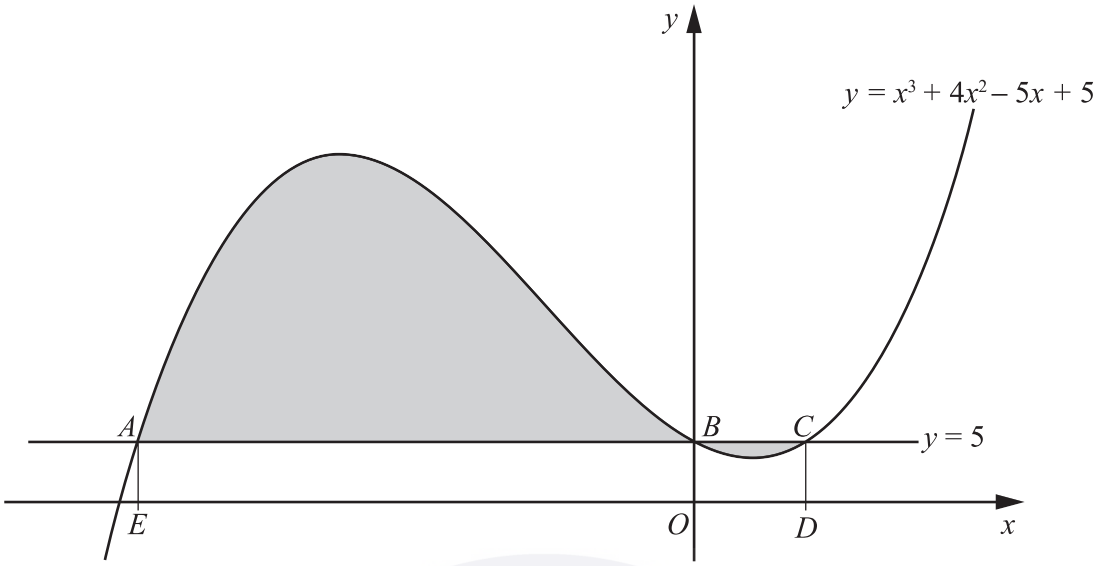
(iii) Using your answer from part **(i)**, find an expression for $f^{-1}(x)$, stating its domain. [3]

10 Solve the equation

(i) $4\sin\left(3x - \frac{\pi}{4}\right) = 3$ for $0 \leqslant x \leqslant \frac{\pi}{2}$ radians, [4]

(ii) $2\tan^2 y + \sec^2 y = 14\sec y + 3$ for $0° \leqslant y \leqslant 360°$. [5]

11



The diagram shows part of the curve $y = x^3 + 4x^2 - 5x + 5$ and the line $y = 5$. The curve and the line intersect at the points A, B and C. The points D and E are on the x-axis and the lines AE and CD are parallel to the y-axis.

(i) Find $\int (x^3 + 4x^2 - 5x + 5)\,dx$. [2]

(ii) Find the area of each of the rectangles $OEAB$ and $OBCD$. [4]

(iii) Hence calculate the total area of the shaded regions enclosed between the line and the curve. You must show all your working. [4]

Question 12 is printed on the next page.

12 The function g is defined, for $x > -\frac{1}{2}$, by $g(x) = \frac{3}{2x+1}$.

(i) Show that $g'(x)$ is always negative. [2]

(ii) Write down the range of g. [1]

The function h is defined, for all real x, by $h(x) = kx + 3$, where k is a constant.

(iii) Find an expression for $hg(x)$. [1]

(iv) Given that $hg(0) = 5$, find the value of k. [2]

(v) State the domain of hg. [1]

Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

7292744436

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2017**

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.
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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 **15** printed pages and **1** blank page.

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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

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

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

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

Formulae for ΔABC

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

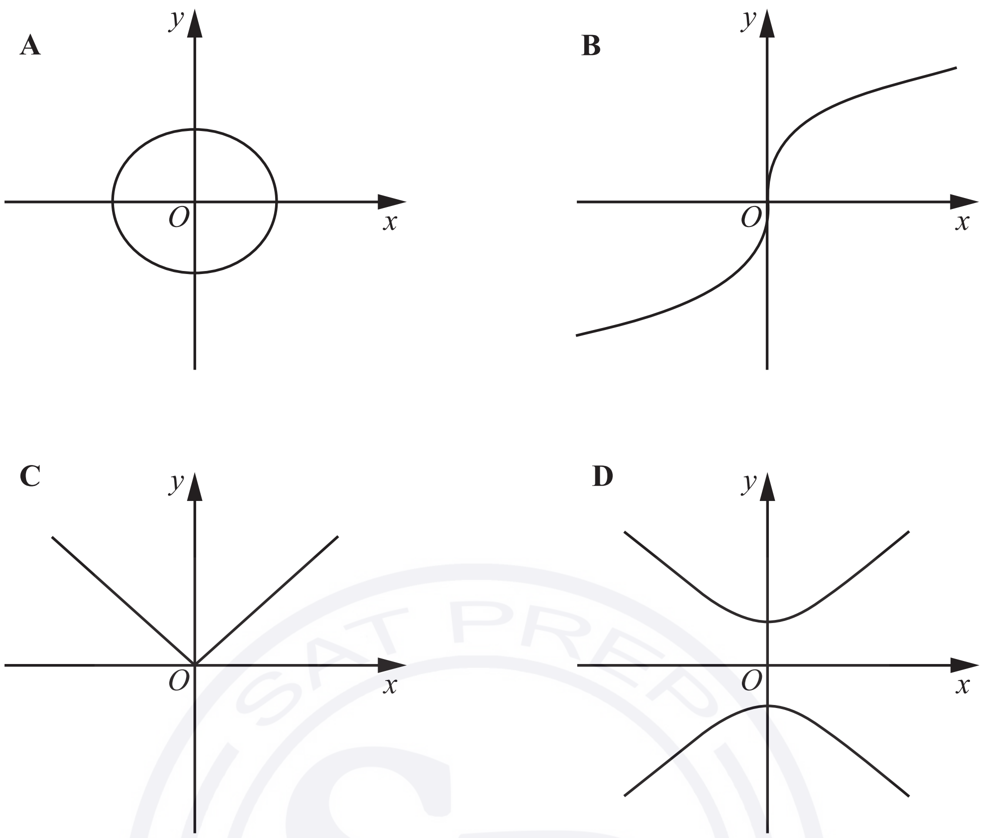
$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

1 **(a)** Solve the equation $7^{2x+5} = 2.5$, giving your answer correct to 2 decimal places. [3]

(b) Express $\dfrac{(5\sqrt{q})^3}{(625p^{12}q)^{\frac{1}{4}}}$ in the form $5^a p^b q^c$, where a, b and c are constants. [3]

2

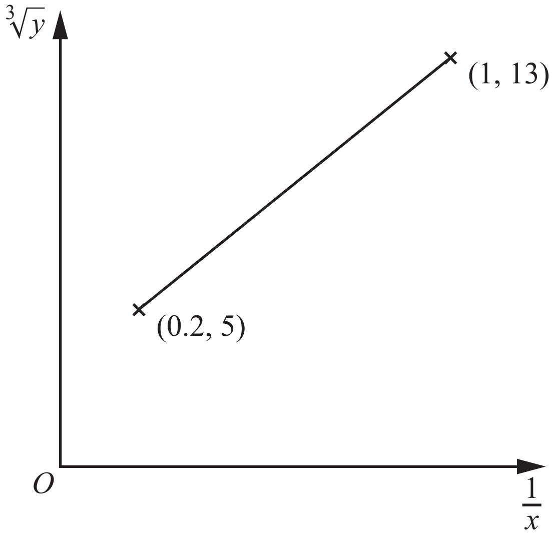


The four graphs above are labelled **A**, **B**, **C** and **D**.

(i) Write down the letter of each graph that represents a function, giving a reason for your choice. [2]

(ii) Write down the letter of each graph that represents a function which has an inverse, giving a reason for your choice. [2]

3



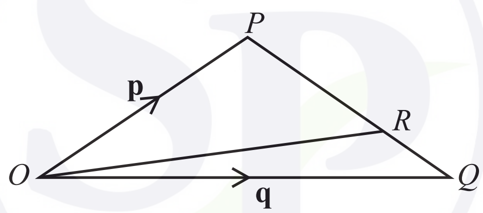
Variables x and y are such that when $\sqrt[3]{y}$ is plotted against $\frac{1}{x}$, a straight line graph passing through the points (0.2, 5) and (1, 13) is obtained. Express y in terms of x. [4]

4 **(a)** Vectors **a**, **b** and **c** are such that $\mathbf{a} = \begin{pmatrix} 5 \\ -6 \end{pmatrix}$, $\mathbf{b} = \begin{pmatrix} 11 \\ -15 \end{pmatrix}$ and $3\mathbf{a} + \mathbf{c} = \mathbf{b}$.

(i) Find **c**. [1]

(ii) Find the unit vector in the direction of **b**. [2]

(b)



In the diagram, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$. The point R lies on PQ such that $PR = 3RQ$. Find $\overrightarrow{OR}$ in terms of **p** and **q**, simplifying your answer. [3]

5 **(a)** How many 5-digit numbers are there that have 5 different digits and are divisible by 5? [3]

(b) A committee of 8 people is to be selected from 9 men and 5 women. Find the number of different committees that can be selected if the committee must have at least 4 women. [3]

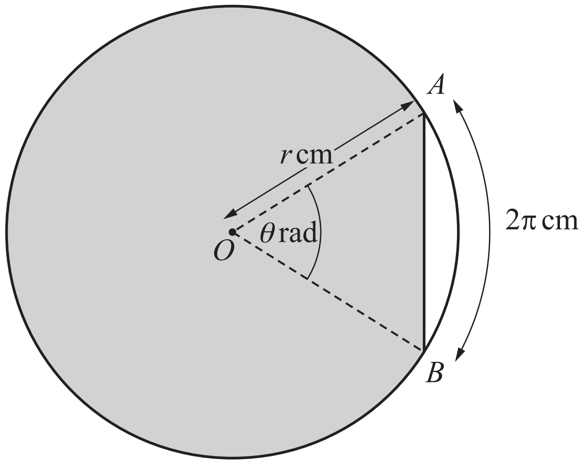
6 The first three terms of the binomial expansion of $(2 - ax)^n$ are $64 - 16bx + 100bx^2$. Find the value of each of the integers n, a and b. [7]

7 Differentiate with respect to x,

(i) $(1+4x)^{10}\cos x$, [4]

(ii) $\frac{e^{4x-5}}{\tan x}$. [4]

8



The diagram shows a circle, centre O of radius r cm, and a chord AB. Angle $AOB = \theta$ radians. The length of the major arc AB is 5 times the length of the minor arc AB. The minor arc AB has length 2π cm.

(i) Find the value of θ and of r. [2]

(ii) Calculate the exact perimeter of the shaded segment. [2]

(iii) Calculate the exact area of the shaded segment. [4]

9 The functions f and g are defined, for $x > 1$, by

$$f(x) = 9\sqrt{x-1},$$
$$g(x) = x^2 + 2.$$

(i) Find an expression for $f^{-1}(x)$, stating its domain. [3]

(ii) Find the exact value of fg(7). [2]

(iii) Solve $gf(x) = 5x^2 + 83x - 95$. [4]

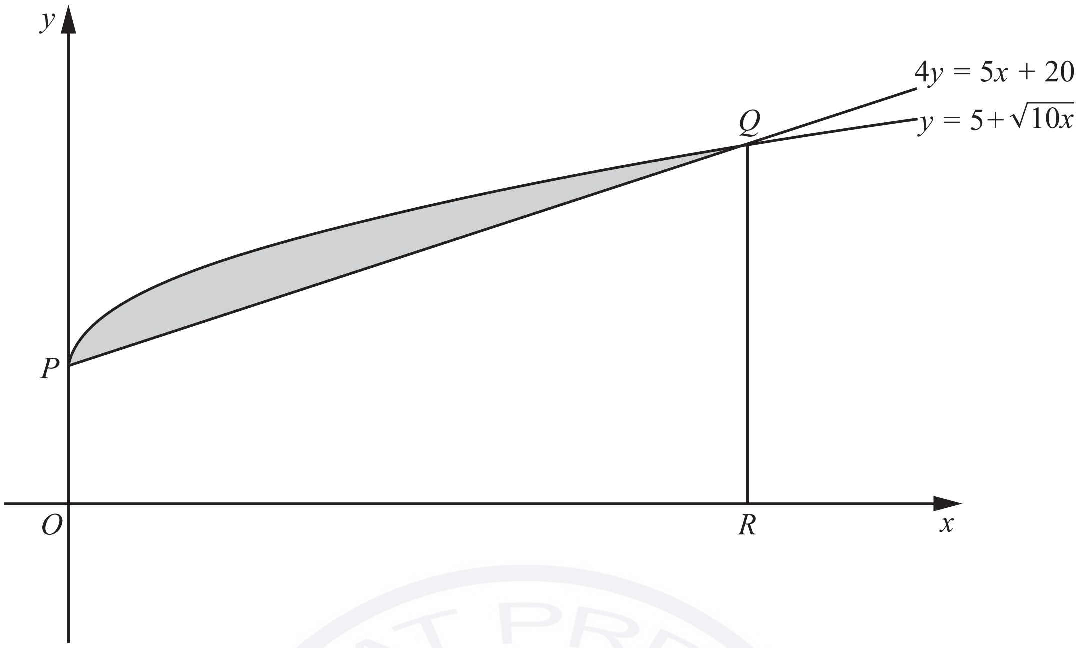
10 Solve the equation

(a) $2|\sin x| = 1$ for $-\pi \leqslant x \leqslant \pi$ radians, [3]

(b) $3\tan(2y + 15°) = 1$ for $0° \leqslant y \leqslant 180°$, [4]

(c) $3\cot^2 z = \operatorname{cosec}^2 z - 7\operatorname{cosec} z + 1$ for $0° \leqslant z \leqslant 360°$. [5]

11



The diagram shows part of the curve $y = 5 + \sqrt{10x}$ and the line $4y = 5x + 20$. The line and curve intersect at the points $P(0, 5)$ and Q. The line QR is parallel to the y-axis.

(i) Find the coordinates of Q. [4]

(ii) Find the area of the shaded region. You must show all your working. [6]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

4214767259

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **February/March 2017**

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.
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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 **15** printed pages and **1** blank page.

DC (LK/SG) 129475/3

CAMBRIDGE International Examinations

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 Solve the equation $|5 - 3x| = 10$. [3]

2 The value, V dollars, of a car aged t years is given by $V = 12\,000\,e^{-0.2t}$.

(i) Write down the value of the car when it was new. [1]

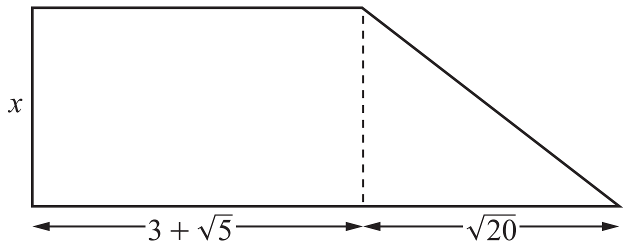
(ii) Find the time it takes for the value to decrease to $\frac{2}{3}$ of the value when it was new. [2]

3 The polynomial $\mathrm{p}(x)$ is $x^4 - 2x^3 - 3x^2 + 8x - 4$.

(i) Show that $\mathrm{p}(x)$ can be written as $(x-1)(x^3 - x^2 - 4x + 4)$. [1]

(ii) Hence write $\mathrm{p}(x)$ as a product of its linear factors, showing all your working. [4]

4 Find the set of values of k for which the line $y = 3x + k$ and the curve $y = 2x^2 - 3x + 4$ do not intersect. [4]

5 

The diagram shows a trapezium made from a rectangle and a right-angled triangle. The dimensions, in centimetres, of the rectangle and triangle are shown. The area, in square centimetres, of the trapezium is $13 + 5\sqrt{5}$. **Without using a calculator**, find the value of x in the form $p + q\sqrt{5}$, where p and q are integers. [5]

6 **(a)** **(i)** Express $\left(\sqrt[3]{-8x^9}\right)\left(\sqrt[6]{x^{-3}}\right)$ in the form ax^b, where a and b are constants to be found. [2]

(ii) Hence solve the equation $\left(\sqrt[3]{-8x^9}\right)\left(\sqrt[6]{x^{-3}}\right) = -6250$. [2]

(b) It is given that $y = \log_a(ax) + 2\log_a(4x-3) - 1$, where a is a positive integer.

(i) Explain why x must be greater than 0.75. [1]

(ii) Show that y can be written as $\log_a(16x^3 - 24x^2 + 9x)$. [3]

(iii) Find the value of x for which $y = \log_a(9x)$. [2]

7 **(a)** Calculate the magnitude and bearing of the resultant velocity of $10\,\mathrm{ms}^{-1}$ on a bearing of 240° and $5\,\mathrm{ms}^{-1}$ due south. [5]

(b) A car travelling east along a road at a velocity of $38\,\mathrm{kmh}^{-1}$ passes a lorry travelling west on the same road at a velocity of $56\,\mathrm{kmh}^{-1}$. Write down the velocity of the lorry relative to the car. [2]

8 The points $A(3, 7)$ and $B(8, 4)$ lie on the line L. The line through the point $C(6, -4)$ with gradient $\frac{1}{6}$ meets the line L at the point D. Calculate

(i) the coordinates of D, [6]

(ii) the equation of the line through D perpendicular to the line $3y - 2x = 10$. [2]

9 **(a)** Find $\int e^{2x+1}\,dx$. [2]

(b) **(i)** Given that $y = \dfrac{x}{\ln x}$, find $\dfrac{dy}{dx}$. [3]

(ii) Hence find $\displaystyle\int\left(\frac{1}{\ln x} - \frac{1}{(\ln x)^2} + \frac{1}{x^2}\right)dx$. [3]

10 Solve, for $0° \leqslant x \leqslant 360°$, the equation

(i) $\cot(2x - 10°) = \frac{3}{4}$, [4]

(ii) $\sin^2 x - \cos^2 x = \cos x$. [5]

11 The functions f and g are defined by

$$f(x) = \frac{x^2 - 2}{x} \text{ for } x \geqslant 2,$$

$$g(x) = \frac{x^2 - 1}{2} \text{ for } x \geqslant 0.$$

(i) State the range of g. [1]

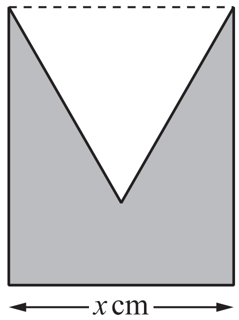
(ii) Explain why fg(1) does not exist. [2]

(iii) Show that $gf(x) = ax^2 + b + \frac{c}{x^2}$, where a, b and c are constants to be found. [3]

(iv) State the domain of gf. [1]

(v) Show that $f^{-1}(x) = \dfrac{x + \sqrt{x^2 + 8}}{2}$. [4]

12 The diagram shows a shape made by cutting an equilateral triangle out of a rectangle of width x cm.



The perimeter of the shape is 20 cm.

(i) Show that the area, A cm^2, of the shape is given by

$$A = 10x - \left(\frac{6+\sqrt{3}}{4}\right)x^2.$$ [3]

(ii) Given that x can vary, find the value of x which produces the maximum area and calculate this maximum area. Give your answers to 2 significant figures. [4]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

1078766162

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2016**

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.
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At the end of the examination, fasten all your work securely together.
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The total number of marks for this paper is 80.

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

DC (NH/JG) 116665/2

CAMBRIDGE International Examinations

[Turn over

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

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

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

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 Solve the equation $|4x-3|=x$. [3]

2 **Without using a calculator**, find the integers a and b such that $\frac{a}{\sqrt{3}+1}+\frac{b}{\sqrt{3}-1}=\sqrt{3}-3$. [5]

3 Solve the equation $2\lg x - \lg\left(\frac{x+10}{2}\right) = 1$. [5]

4 The number of bacteria, N, present in a culture can be modelled by the equation $N = 7000 + 2000e^{-0.05t}$, where t is measured in days. Find

(i) the number of bacteria when $t = 10$, [1]

(ii) the value of t when the number of bacteria reaches 7500, [3]

(iii) the rate at which the number of bacteria is decreasing after 8 days. [3]

5 The curve with equation $y = x^3 + 2x^2 - 7x + 2$ passes through the point A (−2, 16). Find

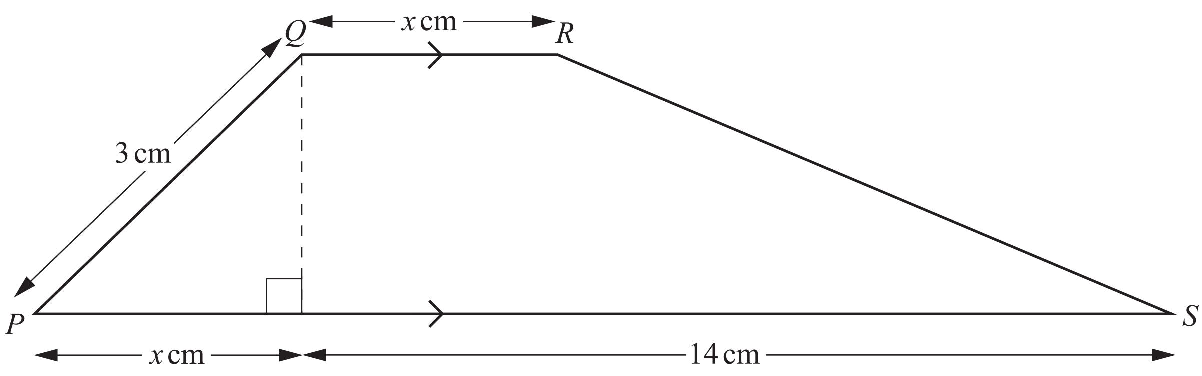
(i) the equation of the tangent to the curve at the point A, [3]

(ii) the coordinates of the point where this tangent meets the curve again. [5]

6 **(i)** Prove that $\dfrac{\cos x}{1+\tan x}-\dfrac{\sin x}{1+\cot x}=\cos x-\sin x.$ [4]

(ii) Hence solve the equation $\dfrac{\cos x}{1+\tan x}-\dfrac{\sin x}{1+\cot x}=3\sin x-4\cos x$ for $-180° < x < 180°$. [4]

7



(i) Show that the area, $A\,\text{cm}^2$, of the trapezium $PQRS$ is given by $A = (7 + x)\sqrt{9 - x^2}$. [2]

(ii) Given that x can vary, find the stationary value of A. [7]

8 The function f(x) is given by $\mathrm{f}(x) = \dfrac{3x^3 - 1}{x^3 + 1}$ for $0 \leqslant x \leqslant 3$.

(i) Show that $\mathrm{f}'(x) = \dfrac{kx^2}{(x^3+1)^2}$, where k is a constant to be determined. [3]

(ii) Find $\displaystyle\int \frac{x^2}{(x^3+1)^2}\,\mathrm{d}x$ and hence evaluate $\displaystyle\int_1^2 \frac{x^2}{(x^3+1)^2}\,\mathrm{d}x$. [4]

(iii) Find $f^{-1}(x)$, stating its domain. [4]

9 The line $y = kx - 4$, where k is a positive constant, passes through the point P (0, −4) and is a tangent to the curve $x^2 + y^2 - 2y = 8$ at the point T. Find

(i) the value of k, [5]

(ii) the coordinates of T, [3]

(iii) the length of TP. [2]

10 The town of Cambley is 5 km east and p km north of Edwintown so that the position vector of Cambley from Edwintown is $\begin{pmatrix} 5000 \\ 1000p \end{pmatrix}$ metres. Manjit sets out from Edwintown at the same time as Raj sets out from Cambley. Manjit sets out from Edwintown on a bearing of 020° at a speed of $2.5\,\text{ms}^{-1}$ so that her position vector relative to Edwintown after t seconds is given by $\begin{pmatrix} 2.5t\cos 70° \\ 2.5t\cos 20° \end{pmatrix}$ metres. Raj sets out from Cambley on a bearing of 310° at $2\,\text{ms}^{-1}$.

(i) Find the position vector of Raj relative to Edwintown after t seconds. [2]

Manjit and Raj meet after T seconds.

(ii) Find the value of T and of p. [5]

Question 11 is printed on the next page.

11 Mr and Mrs Coldicott have 5 sons and 4 daughters. All 11 members of the family play tennis. Six members of the family enter a tennis competition where teams consist of 4 males and 2 females.

Find the number of different teams of 4 males and 2 females that could be selected if

(i) there are no further restrictions, [2]

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0728441694

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **October/November 2016**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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The total number of marks for this paper is 80.

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

DC (ST/JG) 126423

CAMBRIDGE
International Examinations

Mathematical Formulae

1. ALGEBRA

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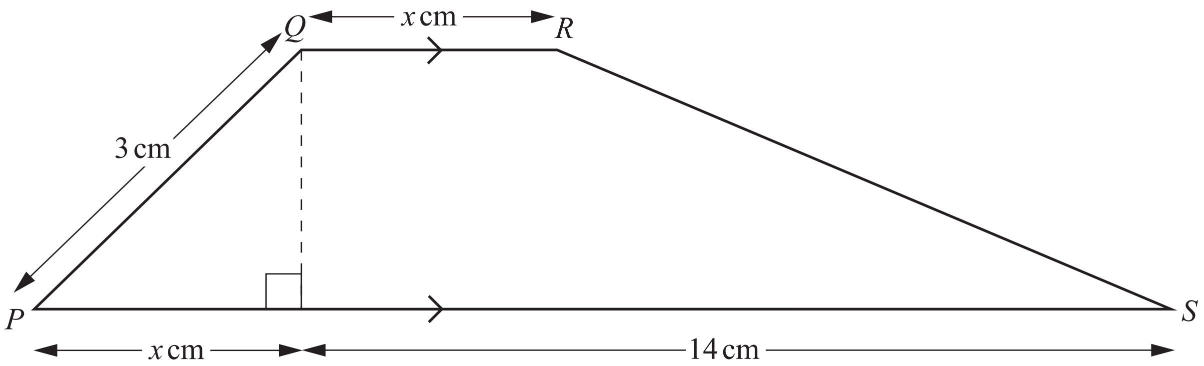
7



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(ii) Find $\displaystyle\int \frac{x^2}{(x^3+1)^2}\,\mathrm{d}x$ and hence evaluate $\displaystyle\int_1^2 \frac{x^2}{(x^3+1)^2}\,\mathrm{d}x$. [4]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

3664532249

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2016**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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DC (LK/SG) 116670/2

CAMBRIDGE International Examinations

[Turn over

Mathematical Formulae

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

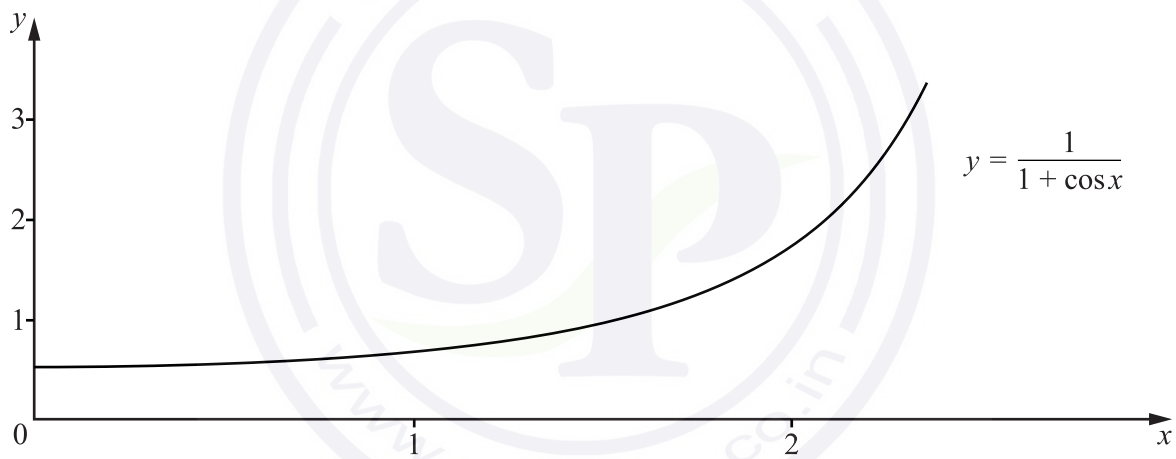
$$\Delta = \frac{1}{2}bc\sin A$$

1 **Without using a calculator**, show that $\dfrac{\sqrt{5}+3\sqrt{3}}{\sqrt{5}+\sqrt{3}} = \sqrt{k}-2$ where k is an integer to be found. [3]

2 Solve the equation $e^{3x} = 6e^{x}$. [3]

3 **(i)** Show that $\frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{\sin x}{1+\cos x}\right)=\frac{1}{1+\cos x}$. [4]

(ii)



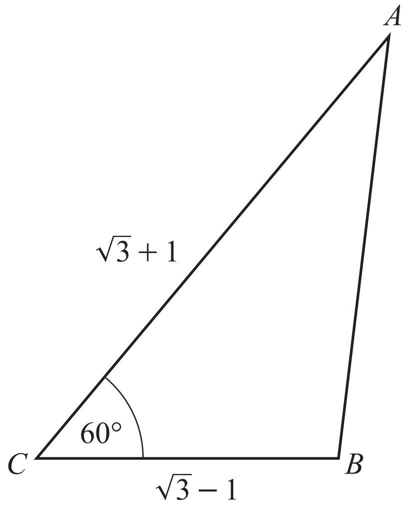
The diagram shows part of the graph of $y=\frac{1}{1+\cos x}$. Use the result from part **(i)** to find the area enclosed by the graph and the lines $x=0$, $x=2$ and $y=0$. [2]

4 The cubic given by $p(x) = x^3 + ax^2 + bx - 24$ is divisible by $x - 2$. When $p(x)$ is divided by $x - 1$ the remainder is -20.

(i) Form a pair of equations in a and b and solve them to find the value of a and of b. [4]

(ii) Factorise $p(x)$ completely and hence solve $p(x) = 0$. [4]

5 In this question all lengths are in centimetres.



In the triangle ABC shown above, $AC = \sqrt{3}+1$, $BC = \sqrt{3}-1$ and angle $ACB = 60°$.

(i) **Without using a calculator**, show that the length of $AB = \sqrt{6}$. [3]

(ii) Show that angle $CAB = 15°$. [2]

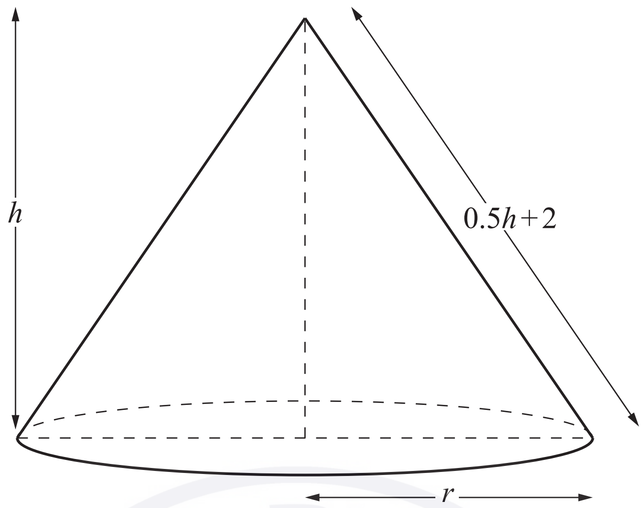
(iii) **Without using a calculator**, find the area of triangle ABC. [2]

6 A curve has equation $y = 7 + \tan x$. Find

(i) the equation of the tangent to the curve at the point where $x = \frac{\pi}{4}$, [4]

(ii) the values of x between 0 and π radians for which $\frac{dy}{dx} = y$. [4]

7 In this question all lengths are in metres.



A conical tent is to be made with height h, base radius r and slant height $0.5h + 2$, as shown in the diagram.

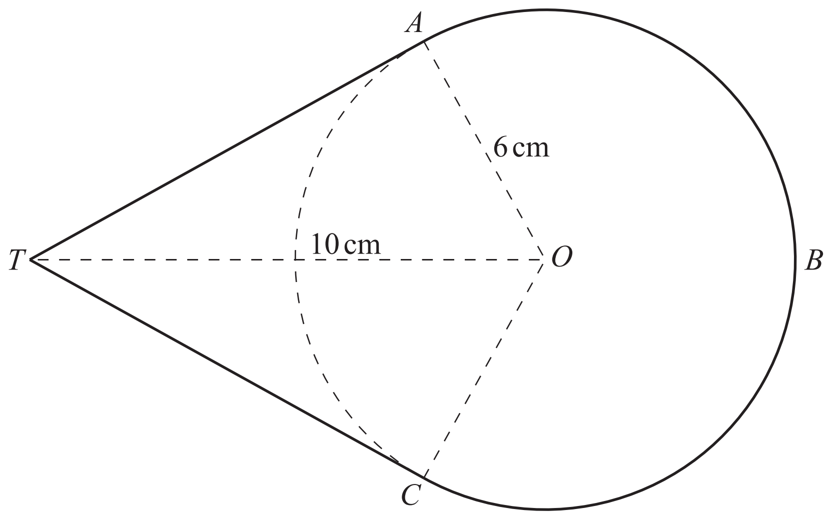
(i) Show that $r^2 = 2h + 4 - 0.75h^2$. [2]

The volume of the tent, V, is given by $\frac{1}{3}\pi r^2 h$.

(ii) Given that h can vary find, correct to 2 decimal places, the value of h which gives a stationary value of V. [5]

(iii) Determine the nature of this stationary value. [2]

8



The points A, B and C lie on a circle centre O, radius 6 cm. The tangents to the circle at A and C meet at the point T. The length of OT is 10 cm. Find

(i) the angle TOA in radians, [2]

(ii) the area of the region *TABCT*, [6]

(iii) the perimeter of the region *TABCT*. [2]

9 In this question $\mathbf{i}$ is a unit vector due east and $\mathbf{j}$ is a unit vector due north. Units of length and velocity are metres and metres per second respectively.

The initial position vectors of particles A and B, relative to a fixed point O, are $\mathbf{i} + 5\mathbf{j}$ and $q\mathbf{i} - 15\mathbf{j}$ respectively. A and B start moving at the same time. A moves with velocity $p\mathbf{i} - 3\mathbf{j}$ and B moves with velocity $3\mathbf{i} - \mathbf{j}$.

(i) Given that A travels with a speed of $5\,\mathrm{ms}^{-1}$, find the value of the positive constant p. [1]

(ii) Find the direction of motion of B as a bearing correct to the nearest degree. [2]

(iii) State the position vector of A after t seconds . [1]

(iv) State the position vector of B after t seconds. [1]

(v) Find the time taken until A and B meet. [2]

(vi) Find the position vector of the point where A and B meet. [1]

(vii) Find the value of the constant q. [1]

10 The functions f and g are defined for $x > 1$ by

$$f(x) = 2 + \ln x,$$

$$g(x) = 2e^x + 3.$$

(i) Find $fg(x)$. [1]

(ii) Find $ff(x)$. [1]

(iii) Find $g^{-1}(x)$. [2]

(iv) Solve the equation $f(x) = 4$. [1]

(v) Solve the equation $gf(x) = 20$. [4]

Question 11 is printed on the next page.

11 It is given that $\mathbf{A} = \begin{pmatrix} 2 & q \\ p & 3 \end{pmatrix}$ and that $\mathbf{A}^2 - 5\mathbf{A} = 2\mathbf{I}$, where **I** is the identity matrix.

(i) Find a relationship connecting the constants p and q. [4]

(ii) Given that p and q are positive and that $\det \mathbf{A} = -3p$, find the value of p and of q. [4]

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

3911999391

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2016**

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.
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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 **15** printed pages and **1** blank page.

DC (RW/SG) 106861/1

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

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

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

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

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 Find the values of x for which $(x-4)(x+2) > 7$. [3]

2 **(a)** Illustrate the statements $A \subset B$ and $B \subset C$ using the Venn diagram below. [1]

(b) It is given that

the elements of set ℰ are the letters of the alphabet,
the elements of set P are the letters in the word *maths*,
the elements of set Q are the letters in the word *exam*.

(i) Write the following using set notation.

The letter h is in the word *maths*. [1]

(ii) Write the following using set notation.

The number of letters occurring in both of the words *maths* and *exam* is two. [1]

(iii) List the elements of the set $P \cap Q'$. [1]

3 Do not use a calculator in this question.

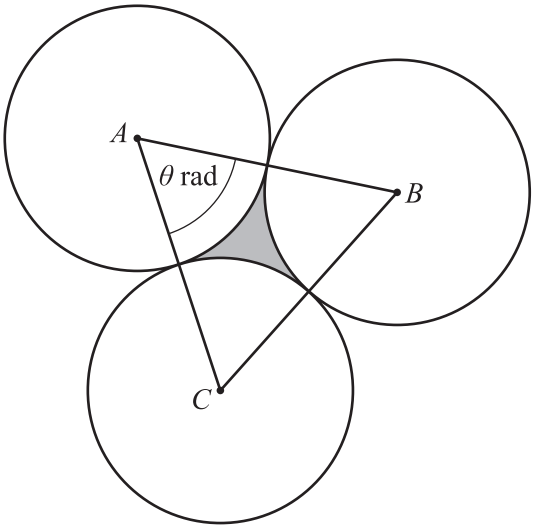
(i) Find the value of $-\log_p p^2$. [1]

(ii) Find $\lg\left(\frac{1}{10^n}\right)$. [1]

(iii) Show that $\frac{\lg 20 - \lg 4}{\log_5 10} = (\lg y)^2$, where y is a constant to be found. [2]

(iv) Solve $\log_r 2x + \log_r 3x = \log_r 600$. [2]

4



The diagram shows 3 circles with centres A, B and C, each of radius 5 cm. Each circle touches the other two circles. Angle BAC is θ radians.

(i) Write down the value of θ. [1]

(ii) Find the area of the shaded region between the circles. [4]

5 Do not use a calculator in this question.

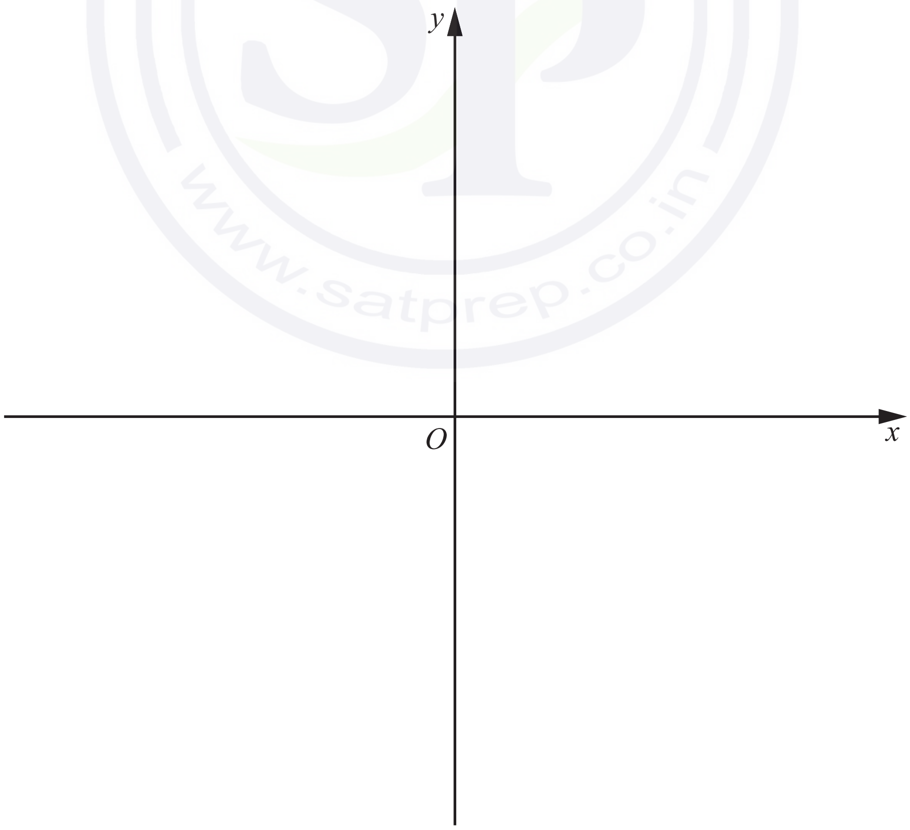
(a) Express $\dfrac{\sqrt{8}}{\sqrt{7}-\sqrt{5}}$ in the form $\sqrt{a}+\sqrt{b}$, where a and b are integers. [3]

(b) Given that $28 + p\sqrt{3} = (q + 2\sqrt{3})^2$, where p and q are integers, find the values of p and of q. [3]

6 **(i)** Express $4x^2 + 8x - 5$ in the form $p(x+q)^2 + r$, where p, q and r are constants to be found. [3]

(ii) State the coordinates of the vertex of $y = |4x^2 + 8x - 5|$. [2]

(iii) On the axes below, sketch the graph of $y = |4x^2 + 8x - 5|$, showing the coordinates of the points where the curve meets the axes. [3]



7 O, P, Q and R are four points such that $\overrightarrow{OP} = \mathbf{p}$, $\overrightarrow{OQ} = \mathbf{q}$ and $\overrightarrow{OR} = 3\mathbf{q} - 2\mathbf{p}$.

(i) Find, in terms of **p** and **q**,

(a) $\overrightarrow{PQ}$, [1]

(b) $\overrightarrow{QR}$. [1]

(ii) Justifying your answer, what can be said about the positions of the points P, Q and R? [2]

(iii) Given that $\overrightarrow{OP} = \mathbf{i} + 3\mathbf{j}$ and that $\overrightarrow{OQ} = 2\mathbf{i} + \mathbf{j}$, find the unit vector in the direction $\overrightarrow{OR}$. [3]

8 **(a)** **(i)** Use the Binomial Theorem to expand $(a+b)^4$, giving each term in its simplest form. [2]

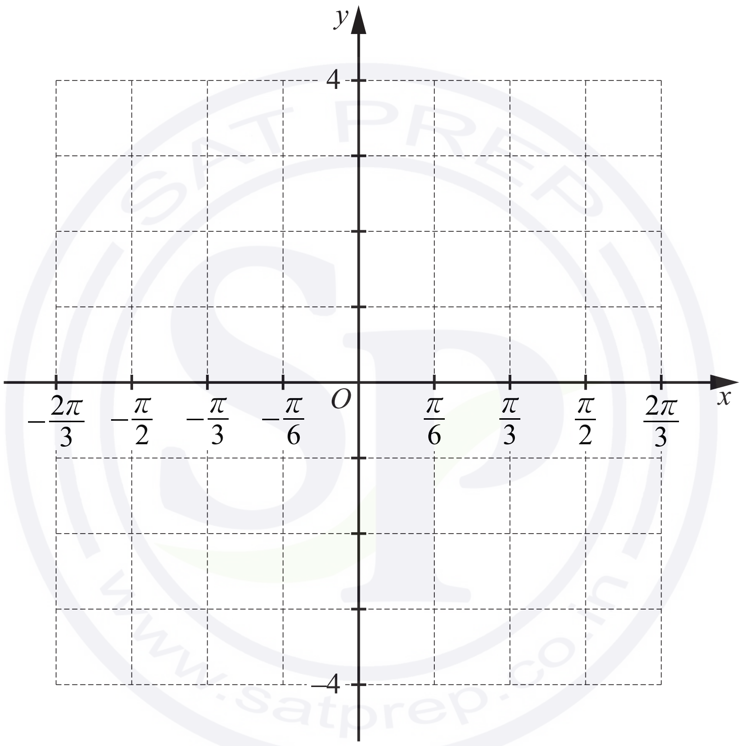
(ii) Hence find the term independent of x in the expansion of $\left(2x+\frac{1}{5x}\right)^4$. [2]

(b) The coefficient of x^3 in the expansion of $\left(1+\frac{x}{2}\right)^n$ equals $\frac{5n}{12}$. Find the value of the positive integer n. [3]

9 **(a)** Given that $y = a\tan bx + c$ has period $\frac{\pi}{4}$ radians and passes through the points $(0, -2)$ and $\left(\frac{\pi}{16}, 0\right)$, find the value of each of the constants a, b and c. [3]

a = ... b = ... c = ...

(b) **(i)** On the axes below, draw the graph of $y = 2\cos 3x + 1$ for $-\frac{2\pi}{3} \leqslant x \leqslant \frac{2\pi}{3}$ radians. [3]



(ii) Using your graph, or otherwise, find the exact solutions of $(2\cos 3x + 1)^2 = 1$ for $-\frac{2\pi}{3} \leqslant x \leqslant \frac{2\pi}{3}$ radians. [2]

10 **(a)** **(i)** Find how many 5-digit even numbers can be made using each of the digits 1, 2, 3, 4, 5 once only. [2]

(ii) Find how many different 3-digit numbers can be made using the digits 1, 2, 3, 4, 5 if each digit can be used once only. [2]

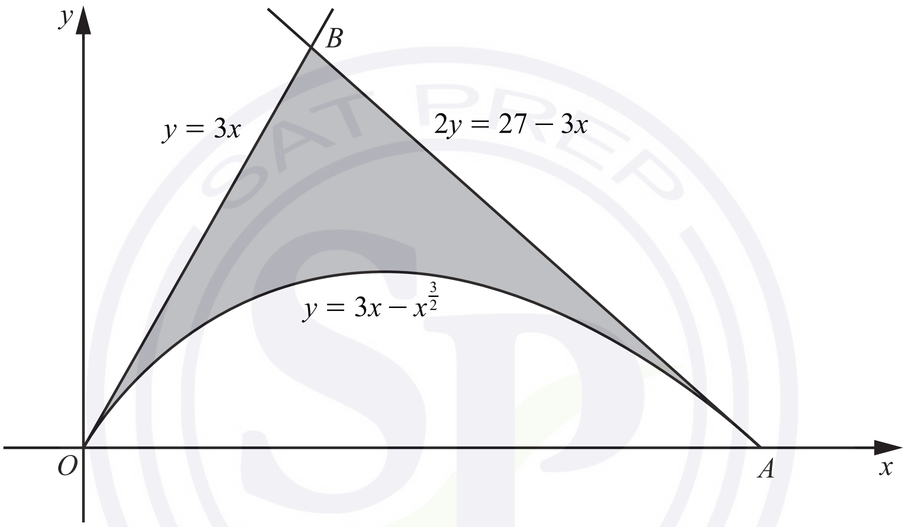
(b) A man and two women are to sit in a row of five empty chairs. Calculate the number of ways they can be seated if

(i) the two women must sit next to each other, [2]

(ii) all three people must sit next to each other. [2]

11 **(i)** Find $\int\left(3x - x^{\frac{3}{2}}\right)\mathrm{d}x$. [2]

The diagram shows part of the curve $y = 3x - x^{\frac{3}{2}}$ and the lines $y = 3x$ and $2y = 27 - 3x$. The curve and the line $y = 3x$ meet the x-axis at O and the curve and the line $2y = 27 - 3x$ meet the x-axis at A.



(ii) Find the coordinates of A. [1]

(iii) Verify that the coordinates of B are $(3, 9)$. [1]

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

12 A curve has equation $y = \dfrac{2x-5}{x-1} - 12x$.

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

(ii) Find $\dfrac{d^2y}{dx^2}$. [2]

(iii) Find the coordinates of the stationary points of the curve and determine their nature. [5]

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

9662401708

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2016**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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The total number of marks for this paper is 80.

This document consists of **12** printed pages.

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CAMBRIDGE International Examinations

[Turn over

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

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

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

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)** Given that $x^2 + 2kx + 4k - 3 = 0$ has no real roots, show that k satisfies $k^2 - 4k + 3 < 0$. [2]

(ii) Solve the inequality $k^2 - 4k + 3 < 0$. [2]

2 Variables x and y are related by the equation $y = \frac{5x - 1}{3 - x}$.

(i) Find $\frac{dy}{dx}$, simplifying your answer. [2]

(ii) Hence find the approximate change in x when y increases from 9 by the small amount 0.07. [3]

3 A team of 3 people is to be selected from 7 women and 6 men. Find the number of different teams that could be selected if there must be more women than men on the team. [3]

4 **Do not use a calculator in this question.**

The polynomial $\mathrm{p}(x) = 2x^3 - 3x^2 + qx + 56$ has a factor $x - 2$.

(i) Show that $q = -30$. [1]

(ii) Factorise $\mathrm{p}(x)$ completely and hence state all the solutions of $\mathrm{p}(x) = 0$. [4]

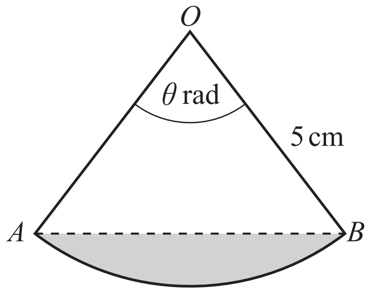
5 The coordinates of three points are $A(-2, 6)$, $B(6, 10)$ and $C(p, 0)$.

(i) Find the coordinates of M, the mid-point of AB. [2]

(ii) Given that CM is perpendicular to AB, find the value of the constant p. [2]

(iii) Find angle MCB. [3]

6



The diagram shows a sector of a circle with centre O and radius 5 cm. The length of the arc AB is 7 cm. Angle AOB is θ radians.

(i) Explain why θ must be greater than 1 radian. [1]

(ii) Find the value of θ. [2]

(iii) Calculate the area of the sector AOB. [2]

(iv) Calculate the area of the shaded segment. [2]

7 The matrix $\mathbf{A}$ is $\begin{pmatrix} 4 & 5 \\ 3 & 2 \end{pmatrix}$ and the matrix $\mathbf{B}$ is $\begin{pmatrix} 4 & 2 \\ 1 & 3 \end{pmatrix}$.

(i) Find the matrix $\mathbf{C}$ such that $\mathbf{C} = 3\mathbf{A} + \mathbf{B}$. [2]

(ii) Show that $\det(\mathbf{AB}) = \det\mathbf{A} \times \det\mathbf{B}$. [4]

(iii) Find the matrix $(\mathbf{AB})^{-1}$. [2]

8 Find the coordinates of the points of intersection of the curve $4 + \frac{5}{y} + \frac{3}{x} = 0$ and the line $y = 15x + 10$. [6]

9 **(a)** Find $\int \frac{x^3 + x^2 + 1}{x^2} \mathrm{d}x$. [3]

(b) **(i)** Find $\int \sin(5x + \pi)\,\mathrm{d}x$. [2]

(ii) Hence evaluate $\int_{-\frac{\pi}{5}}^{0} \sin(5x + \pi)\,\mathrm{d}x$. [2]

10 **(a)** The graph of the curve $y = p(4^{2x}) - q(4^{x})$ passes through the points (0, 2) and (0.5, 14). Find the value of p and of q. [3]

(b) The variables x and y are connected by the equation $y = 10^{2x} - 2(10^{x})$. Using the substitution $u = 10^{x}$, or otherwise, find the exact value of x when $y = 24$. [3]

(c) Solve $\log_2(x+1) - \log_2 x = 3$. [3]

11 **(a)** A function f is defined, for all real x, by

$$f(x) = x - x^2.$$

Find the greatest value of $f(x)$ and the value of x for which this occurs. [3]

(b) The domain of $g(x) = x - x^2$ is such that $g^{-1}(x)$ exists. Explain why $x \geqslant 1$ is a suitable domain for $g(x)$. [1]

(c) The functions h and k are defined by

$$h: x \mapsto \lg(x+2) \quad \text{for } x > -2,$$
$$k: x \mapsto 5 + \sqrt{x-1} \quad \text{for } 1 < x < 101.$$

(i) Find hk(10). [2]

(ii) Find $k^{-1}(x)$, stating its domain and range. [5]

Question 12 is printed on the next page.

12 Solve the equation

(i) $8\sin^2 A + 2\cos A = 7$ for $0° \leqslant A \leqslant 180°$, [4]

(ii) $\operatorname{cosec}(3B + 1) = 2.5$ for $0 \leqslant B \leqslant \pi$ radians. [4]

Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

1509950933

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2016**

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.
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The total number of marks for this paper is 80.

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CAMBRIDGE International Examinations

[Turn over

Mathematical Formulae

1. ALGEBRA

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1 Find the values of x for which $(x-4)(x+2) > 7$. [3]

2 **(a)** Illustrate the statements $A \subset B$ and $B \subset C$ using the Venn diagram below. [1]

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the elements of set ℰ are the letters of the alphabet,
the elements of set P are the letters in the word *maths*,
the elements of set Q are the letters in the word *exam*.

(i) Write the following using set notation.

The letter h is in the word *maths*. [1]

(ii) Write the following using set notation.

The number of letters occurring in both of the words *maths* and *exam* is two. [1]

(iii) List the elements of the set $P \cap Q'$. [1]

3 Do not use a calculator in this question.

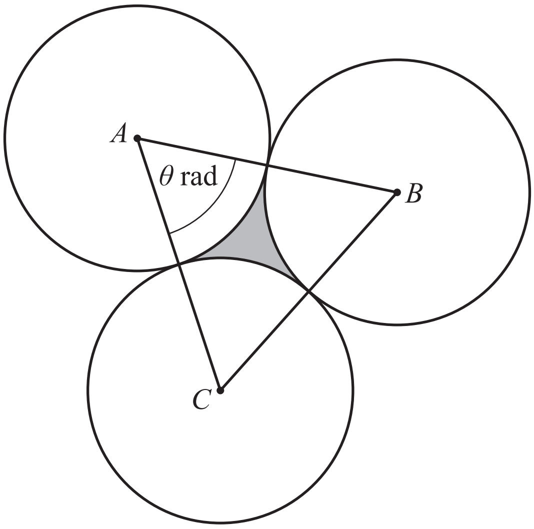
(i) Find the value of $-\log_p p^2$. [1]

(ii) Find $\lg\left(\dfrac{1}{10^n}\right)$. [1]

(iii) Show that $\dfrac{\lg 20 - \lg 4}{\log_5 10} = (\lg y)^2$, where y is a constant to be found. [2]

(iv) Solve $\log_r 2x + \log_r 3x = \log_r 600$. [2]

4



The diagram shows 3 circles with centres A, B and C, each of radius 5 cm. Each circle touches the other two circles. Angle BAC is θ radians.

(i) Write down the value of θ. [1]

(ii) Find the area of the shaded region between the circles. [4]

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(a) Express $\dfrac{\sqrt{8}}{\sqrt{7}-\sqrt{5}}$ in the form $\sqrt{a}+\sqrt{b}$, where a and b are integers. [3]

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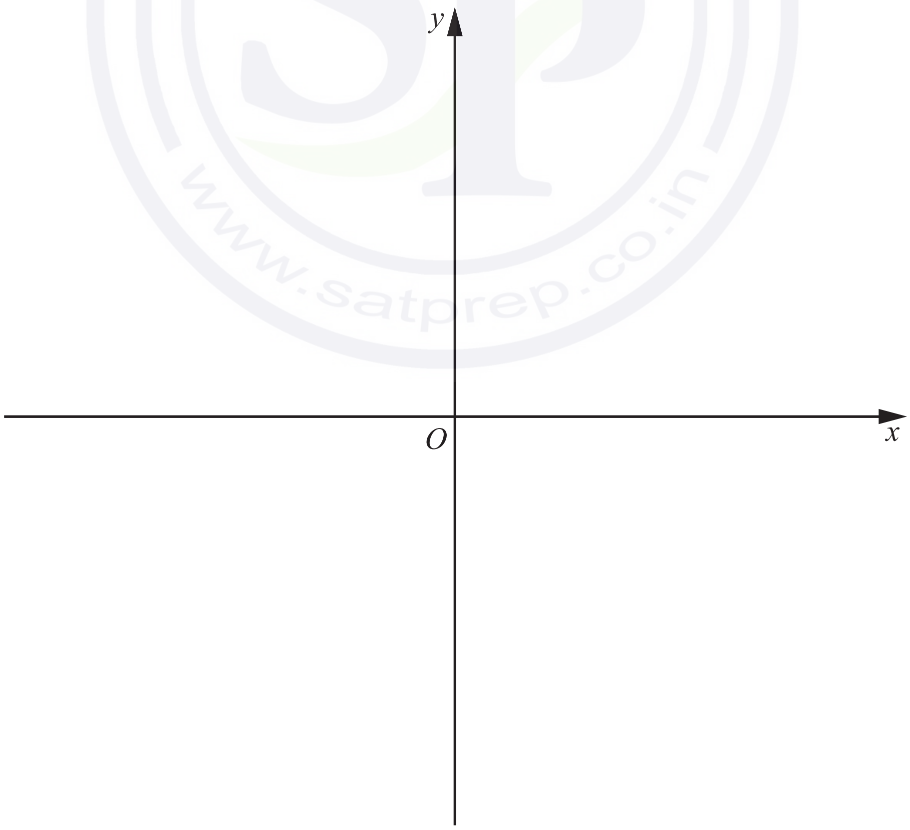
(iii) On the axes below, sketch the graph of $y = |4x^2 + 8x - 5|$, showing the coordinates of the points where the curve meets the axes. [3]



7 O, P, Q and R are four points such that $\overrightarrow{OP} = \mathbf{p}$, $\overrightarrow{OQ} = \mathbf{q}$ and $\overrightarrow{OR} = 3\mathbf{q} - 2\mathbf{p}$.

(i) Find, in terms of **p** and **q**,

(a) $\overrightarrow{PQ}$, [1]

(b) $\overrightarrow{QR}$. [1]

(ii) Justifying your answer, what can be said about the positions of the points P, Q and R? [2]

(iii) Given that $\overrightarrow{OP} = \mathbf{i} + 3\mathbf{j}$ and that $\overrightarrow{OQ} = 2\mathbf{i} + \mathbf{j}$, find the unit vector in the direction $\overrightarrow{OR}$. [3]

8 **(a)** **(i)** Use the Binomial Theorem to expand $(a+b)^4$, giving each term in its simplest form. [2]

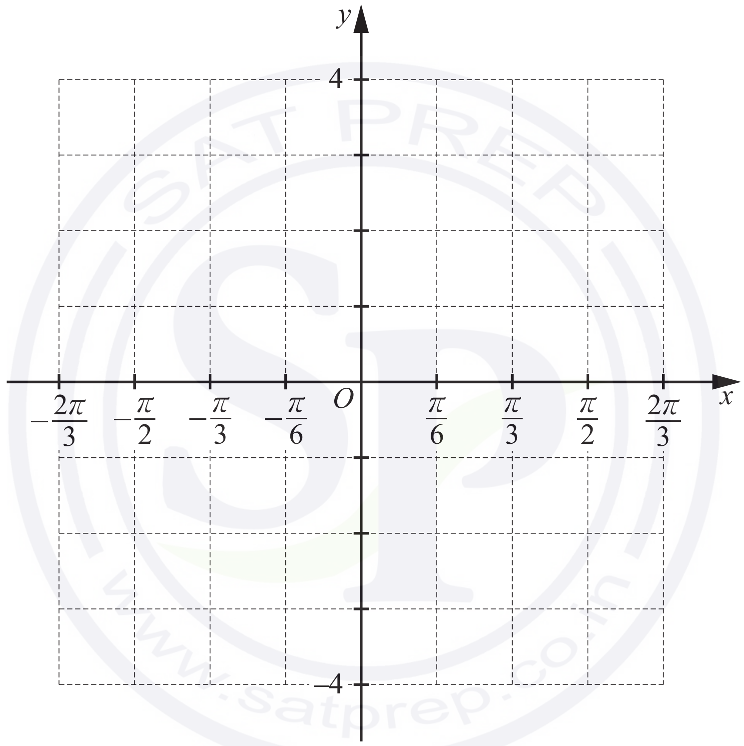
(ii) Hence find the term independent of x in the expansion of $\left(2x+\frac{1}{5x}\right)^4$. [2]

(b) The coefficient of x^3 in the expansion of $\left(1+\frac{x}{2}\right)^n$ equals $\frac{5n}{12}$. Find the value of the positive integer n. [3]

9 **(a)** Given that $y = a\tan bx + c$ has period $\frac{\pi}{4}$ radians and passes through the points $(0, -2)$ and $\left(\frac{\pi}{16}, 0\right)$, find the value of each of the constants a, b and c. [3]

$a =$ .... $b =$ .... $c =$ ....

(b) **(i)** On the axes below, draw the graph of $y = 2\cos 3x + 1$ for $-\frac{2\pi}{3} \leqslant x \leqslant \frac{2\pi}{3}$ radians. [3]



(ii) Using your graph, or otherwise, find the exact solutions of $(2\cos 3x + 1)^2 = 1$ for $-\frac{2\pi}{3} \leqslant x \leqslant \frac{2\pi}{3}$ radians. [2]

10 (a) (i) Find how many 5-digit even numbers can be made using each of the digits 1, 2, 3, 4, 5 once only. [2]

(ii) Find how many different 3-digit numbers can be made using the digits 1, 2, 3, 4, 5 if each digit can be used once only. [2]

(b) A man and two women are to sit in a row of five empty chairs. Calculate the number of ways they can be seated if

(i) the two women must sit next to each other, [2]

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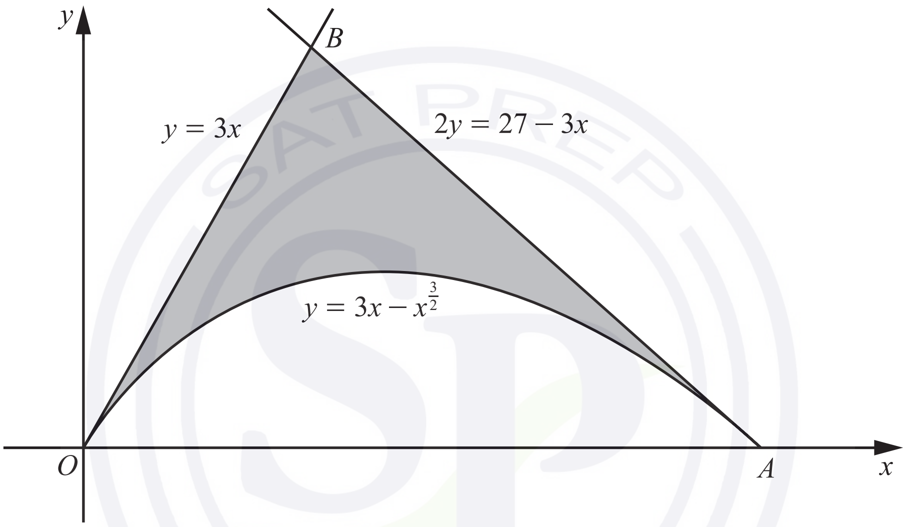
The diagram shows part of the curve $y = 3x - x^{\frac{3}{2}}$ and the lines $y = 3x$ and $2y = 27 - 3x$. The curve and the line $y = 3x$ meet the x-axis at O and the curve and the line $2y = 27 - 3x$ meet the x-axis at A.



(ii) Find the coordinates of A. [1]

(iii) Verify that the coordinates of B are $(3, 9)$. [1]

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

12 A curve has equation $y = \frac{2x-5}{x-1} - 12x$.

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

(ii) Find $\frac{d^2y}{dx^2}$. [2]

(iii) Find the coordinates of the stationary points of the curve and determine their nature. [5]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5764783273

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **February/March 2016**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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

DC (NF/FD) 106874/3

CAMBRIDGE
International Examinations

[Turn over

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

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

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

1 Two variables x and y are such that $y = \frac{5}{\sqrt{x-9}}$ for $x > 9$.

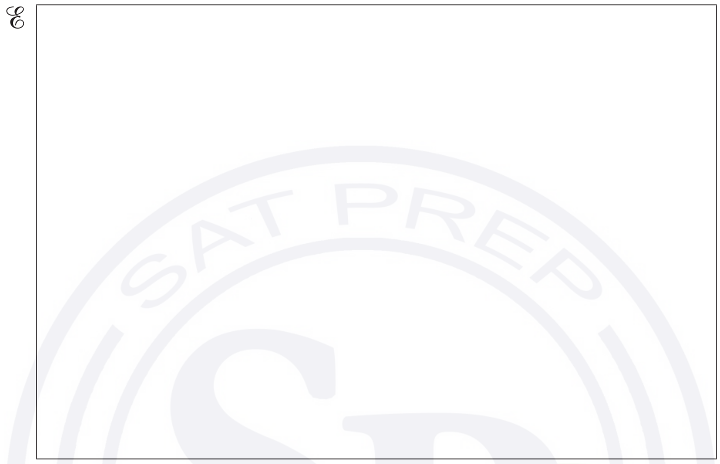
(i) Find an expression for $\frac{dy}{dx}$. [2]

(ii) Hence, find the approximate change in y as x increases from 13 to $13 + h$, where h is small. [2]

2 The sets A, B and C are such that

$$C \subset A,$$
$$B \cap C = \varnothing,$$
$$\mathrm{n}(A \cap B) = 2,$$
$$\mathrm{n}(B) = 12,$$
$$\mathrm{n}(B \cup C) = 14,$$
$$\mathrm{n}(A \cup B) = 19.$$

Complete the Venn diagram to show the sets A, B and C and hence state $\mathrm{n}(A \cap B' \cap C')$.

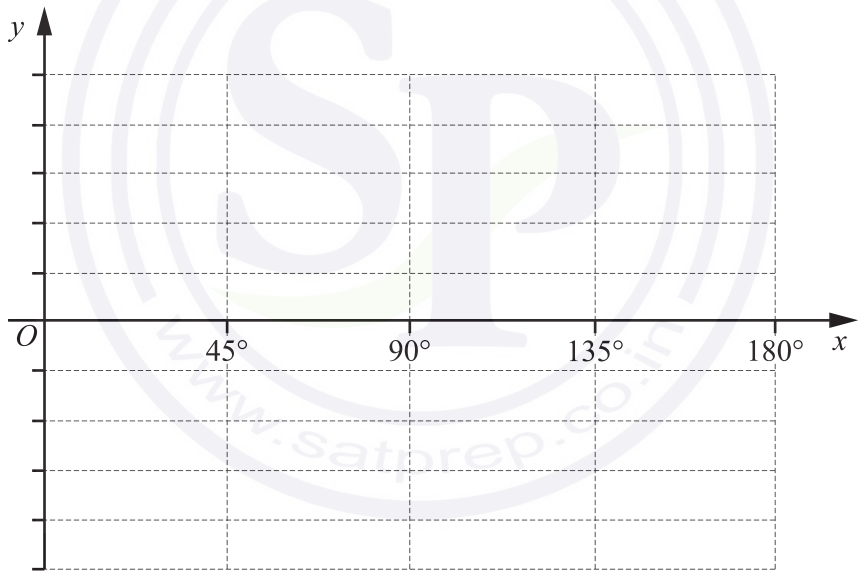


$\mathrm{n}(A \cap B' \cap C')$ = ... [4]

3 Find the equation of the curve which passes through the point (1, 7) and for which $\frac{dy}{dx} = \frac{9x^4 - 3}{x^2}$. [4]

4 **(a)** $f(x) = a\cos bx + c$ has a period of 60°, an amplitude of 10 and is such that $f(0) = 14$. State the values of a, b and c. [2]

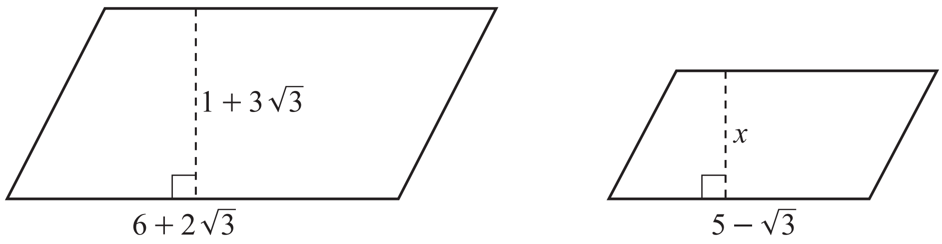
(b) Sketch the graph of $y = 3\sin 4x - 2$ for $0° \leqslant x \leqslant 180°$ on the axes below. [3]



5 **(i)** Find, in ascending powers of x, the first 3 terms of the expansion of $(3 + kx)^7$, where k is a constant. Give each term in its simplest form. [3]

(ii) Given that, in the expansion of $(3 + kx)^7$, the coefficient of x^2 is twice the coefficient of x, find the value of k. [2]

6 Do not use a calculator in this question.



The diagram shows two parallelograms that are similar. The base and height, in centimetres, of each parallelogram is shown. Given that x, the height of the smaller parallelogram, is $\frac{p+q\sqrt{3}}{6}$, find the value of each of the integers p and q. [5]

7 **(a)** Given that $\mathbf{A} = \begin{pmatrix} 4 & 6 & 8 \\ -2 & 0 & 4 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 6 & 1 & 2 \\ 7 & -2 & 1 \end{pmatrix}$, find $\mathbf{A} - 3\mathbf{B}$. [2]

(b) Given that $\mathbf{C} = \begin{pmatrix} -2 & 0 \\ 4 & 1 \end{pmatrix}$ and $\mathbf{D} = \begin{pmatrix} 4 & 3 \\ -3 & -5 \end{pmatrix}$, find

(i) the inverse matrix $\mathbf{C}^{-1}$, [2]

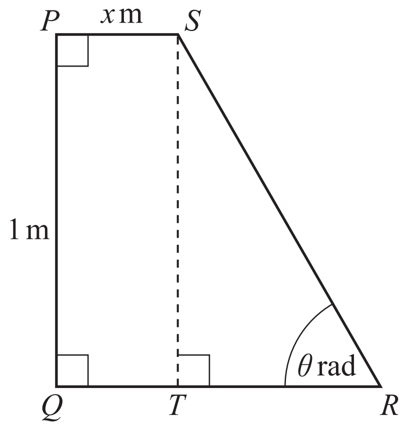
(ii) the matrix $\mathbf{X}$ such that $\mathbf{X}\mathbf{D}^{-1} = \mathbf{C}$. [3]

8 The line $2y = x + 2$ meets the curve $3x^2 + xy - y^2 = 12$ at the points A and B.

(i) Find the coordinates of the points A and B. [5]

(ii) Given that the point C has coordinates (0, 6), show that the triangle ABC is right-angled. [2]

9



PQRS is a quadrilateral with *PS* parallel to *QR*. The perimeter of *PQRS* is 3 m. The length of *PQ* is 1 m and the length of *PS* is x m. The point *T* is on *QR* such that *ST* is parallel to *PQ*. Angle *SRT* is θ radians.

(i) Find an expression for x in terms of θ. [3]

(ii) Show that the area, $A\,\text{m}^2$, of *PQRS* is given by $A = 1 - \dfrac{\operatorname{cosec}\theta}{2}$. [2]

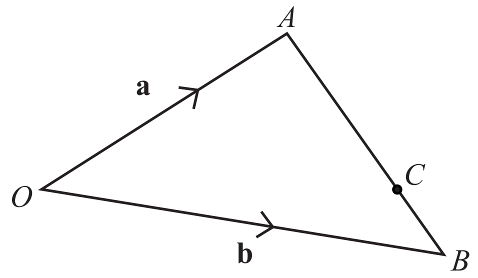
(iii) Hence find the exact value of θ when $A = \left(1 - \dfrac{\sqrt{3}}{3}\right)\text{m}^2$. [2]

10 **(a)** The vectors **p** and **q** are such that $\mathbf{p} = 11\mathbf{i} - 24\mathbf{j}$ and $\mathbf{q} = 2\mathbf{i} + \alpha\mathbf{j}$.

(i) Find the value of each of the constants α and β such that $\mathbf{p} + 2\mathbf{q} = (\alpha + \beta)\mathbf{i} - 20\mathbf{j}$. [3]

(ii) Using the values of α and β found in part **(i)**, find the unit vector in the direction $\mathbf{p} + 2\mathbf{q}$. [2]

(b)



The points A and B have position vectors $\mathbf{a}$ and $\mathbf{b}$ with respect to an origin O. The point C lies on AB and is such that $AB : AC$ is $1 : \lambda$. Find an expression for $\overrightarrow{OC}$ in terms of $\mathbf{a}$, $\mathbf{b}$ and λ. [3]

(c) The points S and T have position vectors $\mathbf{s}$ and $\mathbf{t}$ with respect to an origin O. The points O, S and T do not lie in a straight line. Given that the vector $2\mathbf{s} + \mu\mathbf{t}$ is parallel to the vector $(\mu + 3)\mathbf{s} + 9\mathbf{t}$, where μ is a positive constant, find the value of μ. [3]

11 A curve has equation $y = \dfrac{x}{x^2 + 1}$.

(i) Find the coordinates of the stationary points of the curve. [5]

(ii) Show that $\frac{d^2y}{dx^2} = \frac{px^3 + qx}{(x^2 + 1)^3}$, where p and q are integers to be found, and determine the nature of the stationary points of the curve. [5]

Question 12 is printed on the next page.

12 A particle P is projected from the origin O so that it moves in a straight line. At time t seconds after projection, the velocity of the particle, $v\,\text{ms}^{-1}$, is given by

$$v = 9t^2 - 63t + 90 \ .$$

(i) Show that P first comes to instantaneous rest when $t = 2$. [2]

(ii) Find the acceleration of P when $t = 3.5$. [2]

(iii) Find an expression for the displacement of P from O at time t seconds. [3]

(iv) Find the distance travelled by P

(a) in the first 2 seconds, [2]

(b) in the first 3 seconds. [2]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4033854116

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2015**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

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Mathematical Formulae

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

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

1 It is given that $f(x) = 4x^3 - 4x^2 - 15x + 18$.

(i) Show that $x + 2$ is a factor of $f(x)$. [1]

(ii) Hence factorise $f(x)$ completely and solve the equation $f(x) = 0$. [4]

2 **(i)** Find, in the simplest form, the first 3 terms of the expansion of $(2-3x)^6$, in ascending powers of x. [3]

(ii) Find the coefficient of x^2 in the expansion of $(1+2x)(2-3x)^6$. [2]

3 Relative to an origin O, points A, B and C have position vectors $\begin{pmatrix}5\\4\end{pmatrix}$, $\begin{pmatrix}-10\\12\end{pmatrix}$ and $\begin{pmatrix}6\\-18\end{pmatrix}$ respectively. All distances are measured in kilometres. A man drives at a constant speed directly from A to B in 20 minutes.

(i) Calculate the speed in kmh^{-1} at which the man drives from A to B. [3]

He now drives directly from B to C at the same speed.

(ii) Find how long it takes him to drive from B to C. [3]

4 **(a)** Given that $\mathbf{A} = \begin{pmatrix} 2 & -1 \\ 3 & 5 \\ 7 & 4 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 1 & -2 & 4 \\ -2 & 3 & 0 \end{pmatrix}$, calculate **2BA**. [3]

(b) The matrices **C** and **D** are given by $\mathbf{C} = \begin{pmatrix} 1 & 2 \\ -1 & 6 \end{pmatrix}$ and $\mathbf{D} = \begin{pmatrix} 3 & -2 \\ 1 & 4 \end{pmatrix}$.

(i) Find $\mathbf{C}^{-1}$. [2]

(ii) Hence find the matrix **X** such that **CX + D = I**, where **I** is the identity matrix. [3]

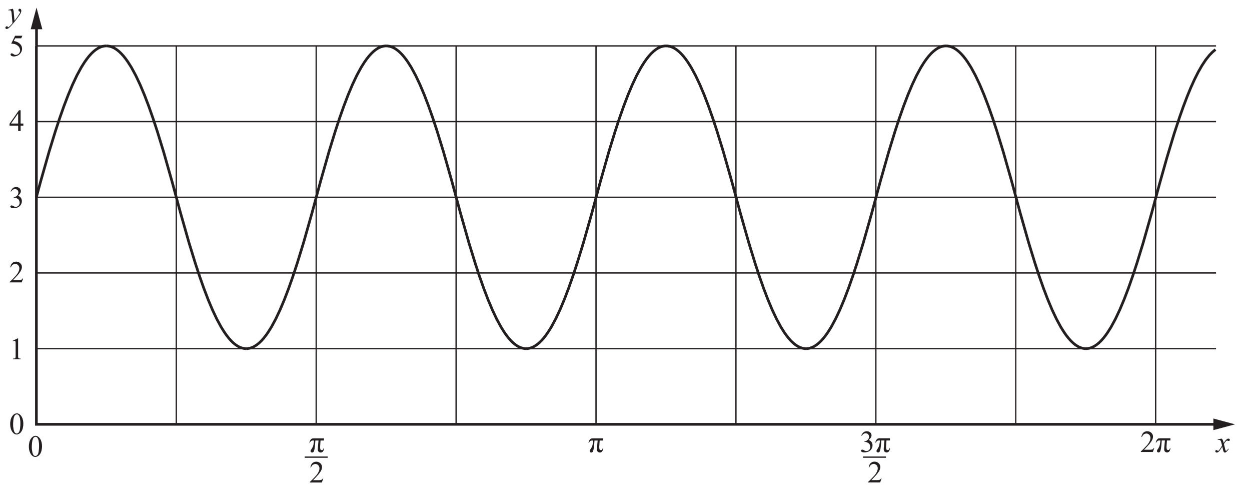
5 **(a)** Solve the following equations to find p and q.

$$8^{q-1} \times 2^{2p+1} = 4^7$$
$$9^{p-4} \times 3^q = 81$$

[4]

(b) Solve the equation $\lg(3x-2) + \lg(x+1) = 2 - \lg 2$. [5]

6



The figure shows part of the graph of $y = a + b\sin cx$.

(i) Find the value of each of the integers a, b and c. [3]

Using your values of a, b and c find

(ii) $\dfrac{dy}{dx}$, [2]

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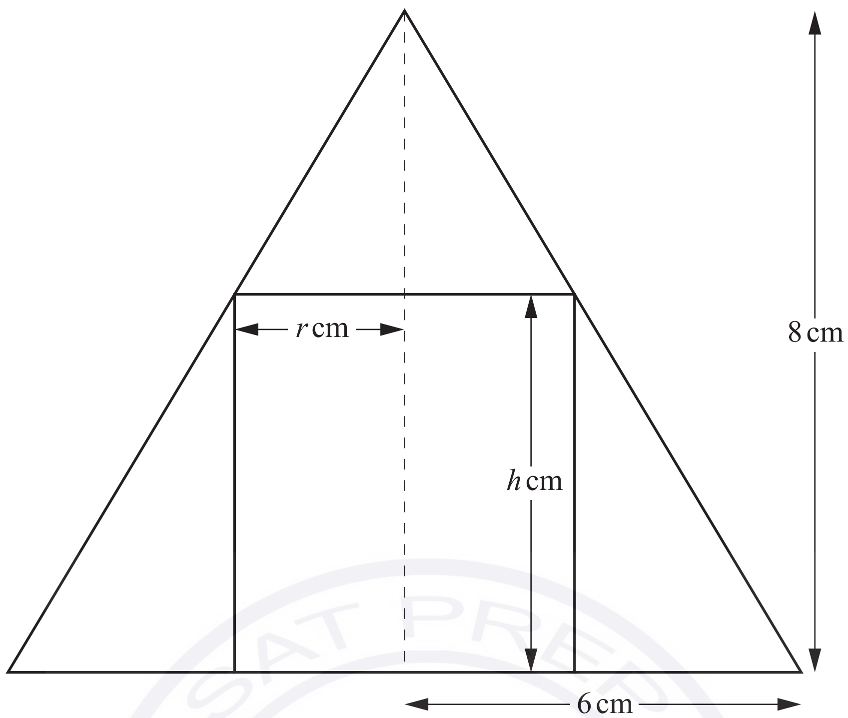
7



A cone, of height 8 cm and base radius 6 cm, is placed over a cylinder of radius r cm and height h cm and is in contact with the cylinder along the cylinder's upper rim. The arrangement is symmetrical and the diagram shows a vertical cross-section through the vertex of the cone.

(i) Use similar triangles to express h in terms of r. [2]

(ii) Hence show that the volume, V cm^3, of the cylinder is given by $V = 8\pi r^2 - \frac{4}{3}\pi r^3$. [1]

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(i) Find the coordinates of C, the point where the line AB cuts the y-axis. [3]

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The perpendicular bisector of AB cuts the y-axis at the point E.

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(v) Show that the area of triangle ABE is four times the area of triangle ECD. [3]

9 Solve the following equations.

(i) $4\sin 2x + 5\cos 2x = 0$ for $0° \leqslant x \leqslant 180°$ [3]

(ii) $\cot^2 y + 3\operatorname{cosec} y = 3$ for $0° \leqslant y \leqslant 360°$ [5]

(iii) $\cos\left(z+\frac{\pi}{4}\right)=-\frac{1}{2}$ for $0 \leqslant z \leqslant 2\pi$ radians, giving each answer as a multiple of π [4]

Question 10 is printed on the next page.

10 A particle is moving in a straight line such that its velocity, $v\,\text{ms}^{-1}$, t seconds after passing a fixed point O is $v = e^{2t} - 6e^{-2t} - 1$.

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CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

9334954202

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **October/November 2015**

2 hours

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Additional Materials: Electronic calculator

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CAMBRIDGE International Examinations

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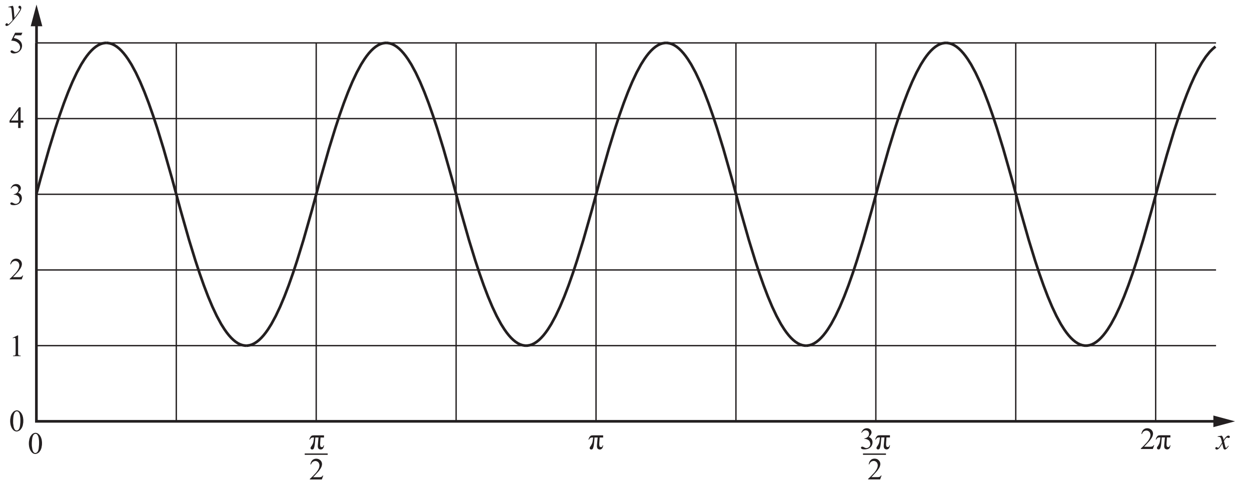

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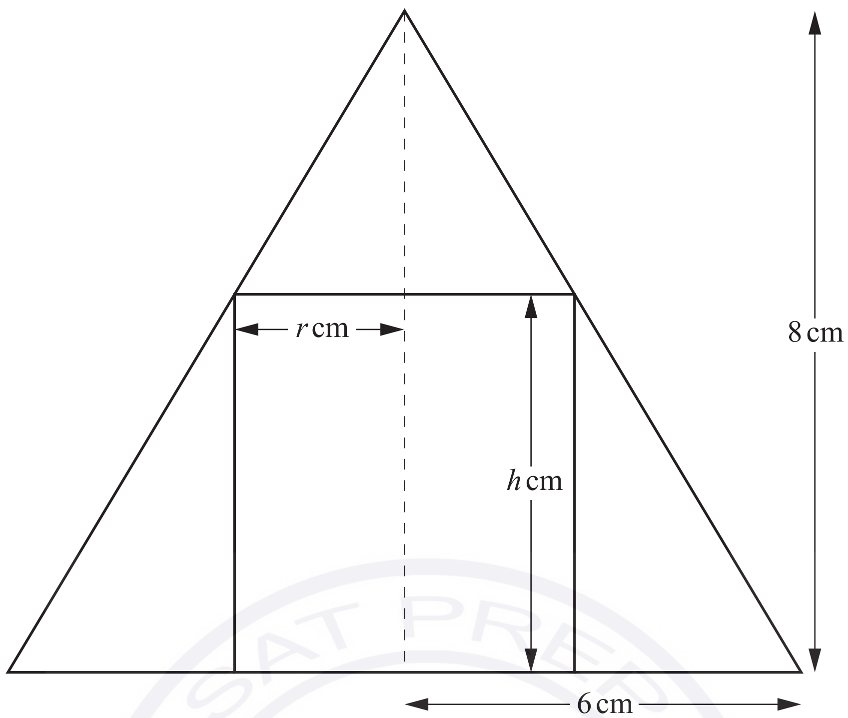

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME										
CENTRE NUMBER						CANDIDATE NUMBER				

1296118221

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2015**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

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1 Find the equation of the tangent to the curve $y = x^3 + 3x^2 - 5x - 7$ at the point where $x = 2$. [5]

2 Find the values of k for which the line $y = 2x + k + 2$ cuts the curve $y = 2x^2 + (k + 2)x + 8$ in two distinct points. [6]

3 **(a)** Given that $y = \dfrac{x^3}{2 - x^2}$, find $\dfrac{dy}{dx}$. [3]

(b) Given that $y = x\sqrt{4x + 6}$, show that $\dfrac{dy}{dx} = \dfrac{k(x + 1)}{\sqrt{4x + 6}}$ and state the value of k. [3]

4 Solve the following simultaneous equations, giving your answers for both x and y in the form $a + b\sqrt{3}$, where a and b are integers.

$$2x + y = 9$$

$$\sqrt{3}x + 2y = 5$$

[5]

5 The roots of the equation $x^3 + ax^2 + bx + c = 0$ are 1, 3 and 3. Show that $c = -9$ and find the value of a and of b. [4]

6 Solve the following equation.

$$\log_2(29x - 15) = 3 + \frac{2}{\log_x 2}$$ [5]

7 The velocity, v ms^{-1}, of a particle travelling in a straight line, t seconds after passing through a fixed point O, is given by $v = \frac{10}{(2+t)^2}$.

(i) Find the acceleration of the particle when $t = 3$. [3]

(ii) Explain why the particle never comes to rest. [1]

(iii) Find an expression for the displacement of the particle from O after time t s. [3]

(iv) Find the distance travelled by the particle between $t = 3$ and $t = 8$. [2]

8 **(i)** Prove that $\sec^2 x + \operatorname{cosec}^2 x = \sec^2 x \operatorname{cosec}^2 x$. [4]

(ii) Hence, or otherwise, solve $\sec^2 x + \operatorname{cosec}^2 x = 4\tan^2 x$ for $90^\circ < x < 270^\circ$. [4]

9 Given that $f(x) = 3x^2 + 12x + 2$,

(i) find values of a, b and c such that $f(x) = a(x+b)^2 + c$, [3]

(ii) state the minimum value of $f(x)$ and the value of x at which it occurs, [2]

(iii) solve $f\left(\frac{1}{y}\right) = 0$, giving each answer for y correct to 2 decimal places. [3]

10 **(i)** Given that $\frac{\mathrm{d}}{\mathrm{d}x}\left(\mathrm{e}^{2-x^2}\right) = kx\mathrm{e}^{2-x^2}$, state the value of k. [1]

(ii) Using your result from part **(i)**, find $\int 3x\mathrm{e}^{2-x^2}\mathrm{d}x$. [2]

(iii) Hence find the area enclosed by the curve $y = 3x\mathrm{e}^{2-x^2}$, the x-axis and the lines $x = 1$ and $x = \sqrt{2}$. [2]

(iv) Find the coordinates of the stationary points on the curve $y = 3xe^{2-x^2}$. [4]

11 The trees in a certain forest are dying because of an unknown virus.

The number of trees, N, surviving t years after the onset of the virus is shown in the table below.

t	1	2	3	4	5	6
N	2000	1300	890	590	395	260

The relationship between N and t is thought to be of the form $N = Ab^{-t}$.

(i) Transform this relationship into straight line form. [1]

(ii) Using the given data, draw this straight line on the grid below. [3]

(iii) Use your graph to estimate the value of A and of b. [3]

If the trees continue to die in the same way, find

(iv) the number of trees surviving after 10 years, [1]

(v) the number of years taken until there are only 10 trees surviving. [2]

Question 12 is printed on the next page.

12 A plane that can travel at $250\,\text{kmh}^{-1}$ in still air sets off on a bearing of 070°. A wind with speed $w\,\text{kmh}^{-1}$ from the south blows the plane off course so that the plane actually travels on a bearing of 060°.

Find, in kmh^{-1}, the resultant speed V of the plane and the windspeed w. [5]

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8456929624

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2015**

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 **15** printed pages and **1** blank page.

DC (LEG/SW) 91464/2

CAMBRIDGE International Examinations

[Turn over

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

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

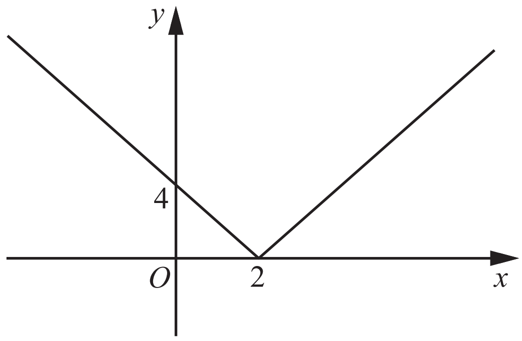
$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

1 **(a)** Write $\log_{27}x$ as a logarithm to base 3. [2]

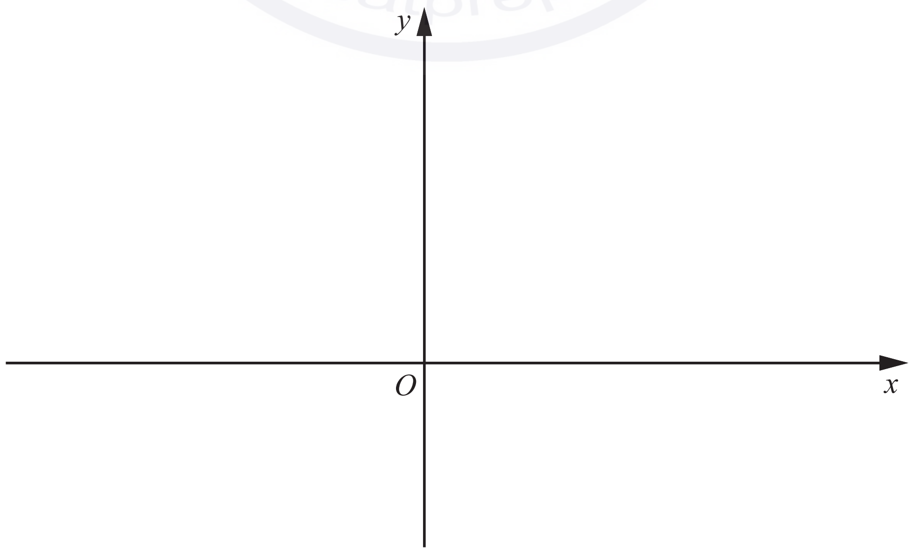
(b) Given that $\log_a y = 3(\log_a 15 - \log_a 3) + 1$, express y in terms of a. [3]

2 **(a)**



The diagram shows the graph of $y = |f(x)|$ passing through $(0, 4)$ and touching the x-axis at $(2, 0)$. Given that the graph of $y = f(x)$ is a straight line, write down the two possible expressions for $f(x)$. [2]

(b) On the axes below, sketch the graph of $y = e^{-x} + 3$, stating the coordinates of any point of intersection with the coordinate axes. [3]



3 **(a)** Find the matrix **A** if $4\mathbf{A}+5\begin{pmatrix}4 & 0 & -1\\ 3 & -2 & 5\end{pmatrix}=\begin{pmatrix}52 & -8 & 19\\ 31 & 2 & 65\end{pmatrix}$. [2]

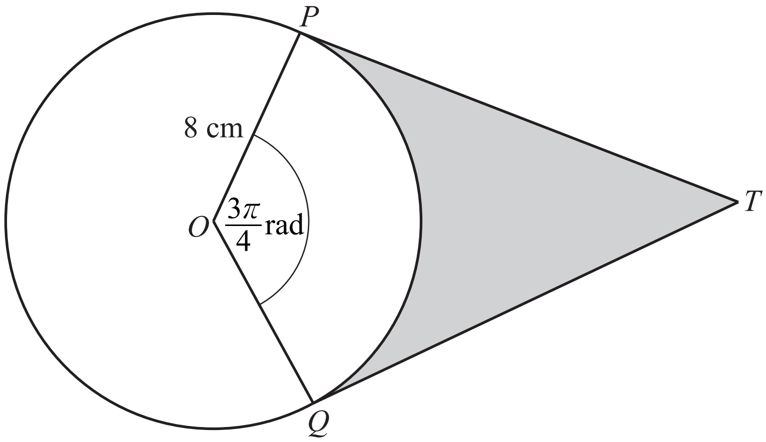
(b) $\mathbf{P}=\begin{pmatrix}30 & 25 & 65\\ 70 & 15 & 80\\ 50 & 40 & 30\\ 40 & 20 & 75\end{pmatrix}$ $\mathbf{Q}=\begin{pmatrix}650 & 500 & 450 & 225\end{pmatrix}$

The matrix **P** represents the number of 4 different televisions that are on sale in each of 3 shops. The matrix **Q** represents the value of each television in dollars.

(i) State, without evaluation, what is represented by the matrix **QP**. [1]

(ii) Given that the matrix $\mathbf{R}=\begin{pmatrix}1\\ 1\\ 1\end{pmatrix}$, state, without evaluation, what is represented by the matrix **QPR**. [1]

4



The diagram shows a circle, centre O, radius 8 cm. The points P and Q lie on the circle. The lines PT and QT are tangents to the circle and angle $POQ = \frac{3\pi}{4}$ radians.

(i) Find the length of PT. [2]

(ii) Find the area of the shaded region. [3]

(iii) Find the perimeter of the shaded region. [2]

5 **(a)** A lock can be opened using only the number 4351. State whether this is a permutation or a combination of digits, giving a reason for your answer. [1]

(b) There are twenty numbered balls in a bag. Two of the balls are numbered 0, six are numbered 1, five are numbered 2 and seven are numbered 3, as shown in the table below.

Number on ball	0	1	2	3
Frequency	2	6	5	7

Four of these balls are chosen at random, without replacement. Calculate the number of ways this can be done so that

(i) the four balls all have the same number, [2]

(ii) the four balls all have different numbers, [2]

(iii) the four balls have numbers that total 3. [3]

6 A particle P is projected from the origin O so that it moves in a straight line. At time t seconds after projection, the velocity of the particle, v ms^{-1}, is given by $v = 2t^2 - 14t + 12$.

(i) Find the time at which P first comes to instantaneous rest. [2]

(ii) Find an expression for the displacement of P from O at time t seconds. [3]

(iii) Find the acceleration of P when $t = 3$. [2]

7 **(a)** The four points O, A, B and C are such that

$$\overrightarrow{OA} = 5\mathbf{a}, \qquad \overrightarrow{OB} = 15\mathbf{b}, \qquad \overrightarrow{OC} = 24\mathbf{b} - 3\mathbf{a}.$$

Show that B lies on the line AC. [3]

(b) Relative to an origin O, the position vector of the point P is $\mathbf{i} - 4\mathbf{j}$ and the position vector of the point Q is $3\mathbf{i} + 7\mathbf{j}$. Find

(i) $|\overrightarrow{PQ}|$, [2]

(ii) the unit vector in the direction $\overrightarrow{PQ}$, [1]

(iii) the position vector of M, the mid-point of PQ. [2]

8 **(a)** **(i)** Find $\int e^{4x+3}\,dx$. [2]

(ii) Hence evaluate $\int_{2.5}^{3} e^{4x+3}\,dx$. [2]

(b) **(i)** Find $\int \cos\left(\frac{x}{3}\right)dx$. [2]

(ii) Hence evaluate $\int_{0}^{\frac{\pi}{6}} \cos\left(\frac{x}{3}\right)dx$. [2]

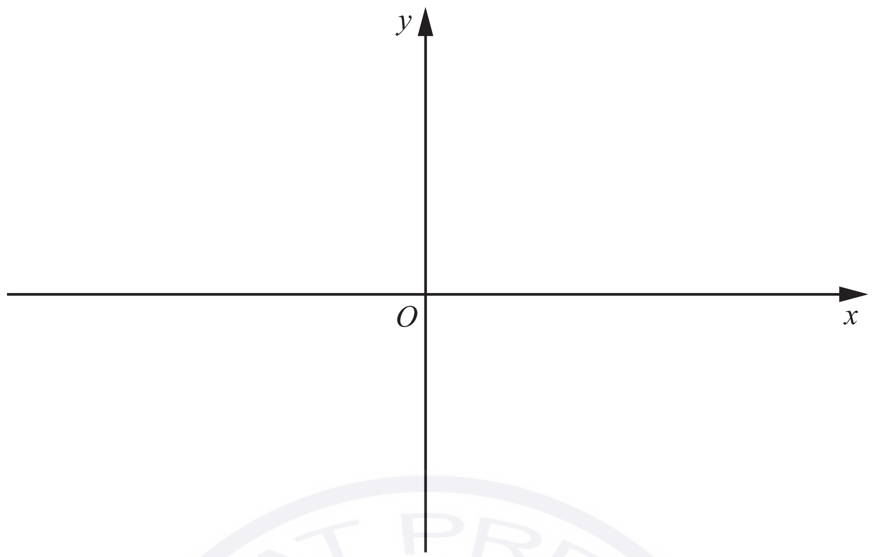
(c) Find $\int (x^{-1} + x)^2 \, \mathrm{d}x$. [4]

9 **(a)** Find the set of values of x for which $4x^2 + 19x - 5 \leqslant 0$. [3]

(b) **(i)** Express $x^2 + 8x - 9$ in the form $(x + a)^2 + b$, where a and b are integers. [2]

(ii) Use your answer to part **(i)** to find the greatest value of $9 - 8x - x^2$ and the value of x at which this occurs. [2]

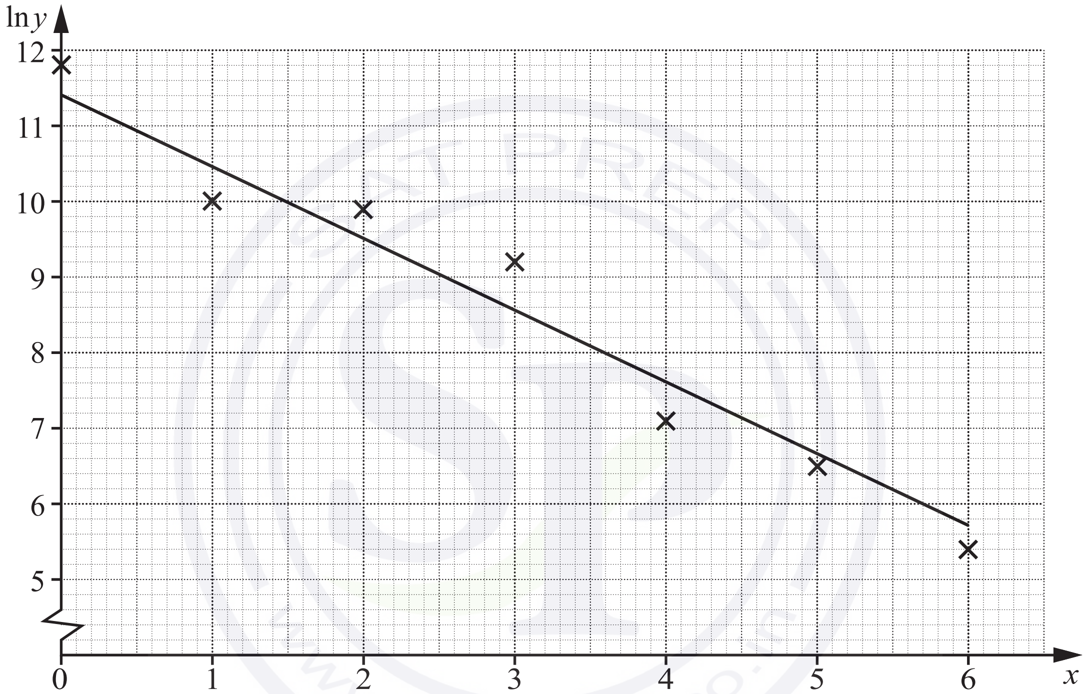
(iii) Sketch the graph of $y = 9 - 8x - x^2$, indicating the coordinates of any points of intersection with the coordinate axes. [2]



10 The relationship between experimental values of two variables, x and y, is given by $y = Ab^x$, where A and b are constants.

(i) By transforming the relationship $y = Ab^x$, show that plotting $\ln y$ against x should produce a straight line graph. [2]

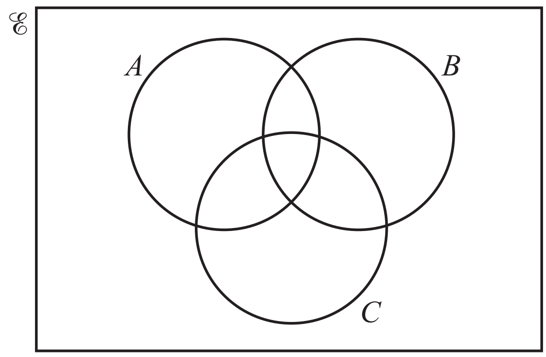
(ii) The diagram below shows the results of plotting $\ln y$ against x for 7 different pairs of values of variables, x and y. A line of best fit has been drawn.



By taking readings from the diagram, find the value of A and of b, giving each value correct to 1 significant figure. [4]

(iii) Estimate the value of y when $x = 2.5$. [2]

11



The Venn diagram above shows the sets A, B and C. It is given that

$n(A \cup B \cup C) = 48$,
$n(A) = 30$, $n(B) = 25$, $n(C) = 15$,
$n(A \cap B) = 7$, $n(B \cap C) = 6$, $n(A' \cap B \cap C') = 16$.

(i) Find the value of x, where $x = n(A \cap B \cap C)$. [3]

(ii) Find the value of y, where $y = n(A \cap B' \cap C)$. [3]

(iii) Hence show that $A' \cap B' \cap C = \varnothing$. [1]

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8878410843

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2015**

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.
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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.

DC (NH/SW) 91465/1

CAMBRIDGE International Examinations

[Turn over

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

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

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Formulae for ΔABC

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

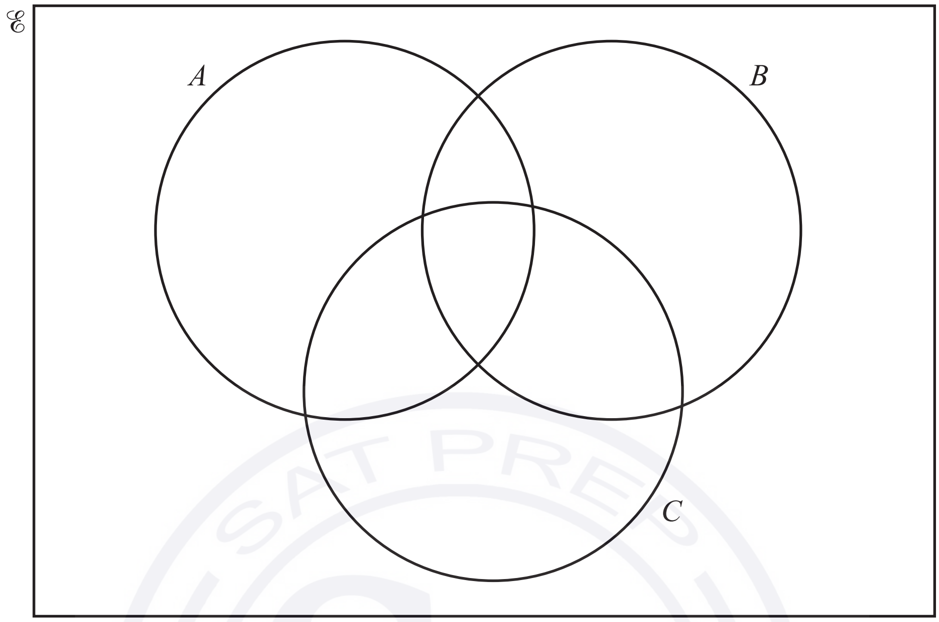
$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

1 The universal set contains all the integers from 0 to 12 inclusive. Given that

$A = \{1, 2, 3, 8, 12\}$, $B = \{0, 2, 3, 4, 6\}$ and $C = \{1, 2, 4, 6, 7, 9, 10\}$,

(i) complete the Venn diagram, [3]



(ii) state the value of $\mathrm{n}(A' \cap B' \cap C)$, [1]

(iii) write down the elements of the set $A' \cap B \cap C$. [1]

2 The table shows the number of passengers in Economy class and in Business class on 3 flights from London to Paris. The table also shows the departure times for the 3 flights and the cost of a single ticket in each class.

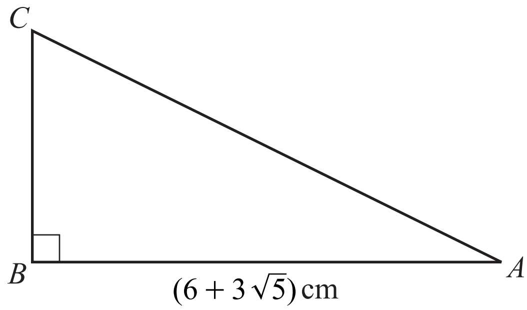
Departure time	Number of passengers in Economy class	Number of passengers in Business class
09 30	60	50
13 30	70	52
15 45	58	34
Single ticket price (£)	120	300

(i) Write down a matrix, **P**, for the numbers of passengers and a matrix, **Q**, of single ticket prices, such that the matrix product **QP** can be found. [2]

(ii) Find the matrix product **QP**. [2]

(iii) Given that $\mathbf{R} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$, explain what information is found by evaluating the matrix product **QPR**. [1]

3 Do not use a calculator in this question.



The diagram shows the right-angled triangle ABC, where $AB = (6+3\sqrt{5})$cm and angle $B = 90°$. The area of this triangle is $\left(\frac{36+15\sqrt{5}}{2}\right)\text{cm}^2$.

(i) Find the length of the side BC in the form $(a+b\sqrt{5})$cm, where a and b are integers. [3]

(ii) Find $(AC)^2$ in the form $(c+d\sqrt{5})\text{cm}^2$, where c and d are integers. [2]

4 A river, which is 80 m wide, flows at $2\,\text{ms}^{-1}$ between parallel, straight banks. A man wants to row his boat straight across the river and land on the other bank directly opposite his starting point. He is able to row his boat in still water at $3\,\text{ms}^{-1}$. Find

(i) the direction in which he must row his boat, [2]

(ii) the time it takes him to cross the river. [3]

5 Solve the simultaneous equations

$$2x^2 + 3y^2 = 7xy,$$
$$x + y = 4.$$

[5]

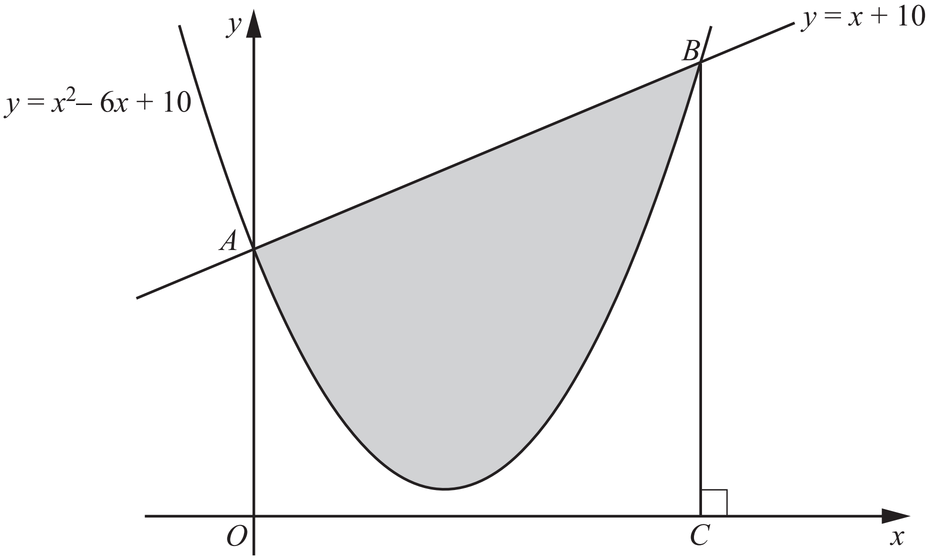
---

6 **(a)** Solve $6^{x-2} = \frac{1}{4}$. [2]

(b) Solve $\log_a 2y^2 + \log_a 8 + \log_a 16y - \log_a 64y = 2\log_a 4$. [4]

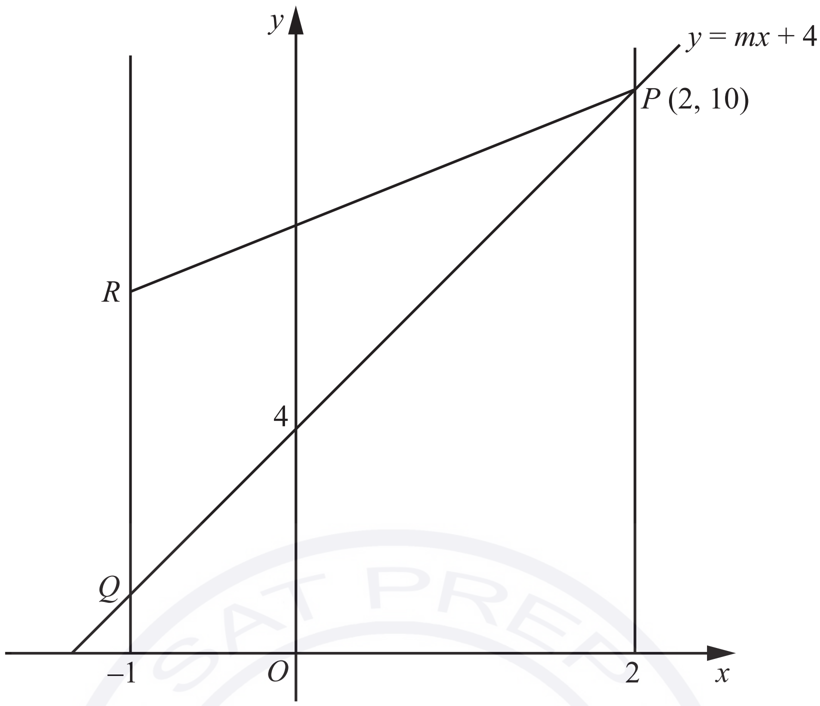
7 In the expansion of $(1+2x)^n$, the coefficient of x^4 is ten times the coefficient of x^2. Find the value of the positive integer, n. [6]

8



The graph of $y = x^2 - 6x + 10$ cuts the y-axis at A. The graphs of $y = x^2 - 6x + 10$ and $y = x + 10$ cut one another at A and B. The line BC is perpendicular to the x-axis. Calculate the area of the shaded region enclosed by the curve and the line AB, showing all your working. [8]

9 Solutions by accurate drawing will not be accepted.



The line $y = mx + 4$ meets the lines $x = 2$ and $x = -1$ at the points P and Q respectively. The point R is such that QR is parallel to the y-axis and the gradient of RP is 1. The point P has coordinates (2, 10).

(i) Find the value of m. [2]

(ii) Find the y-coordinate of Q. [1]

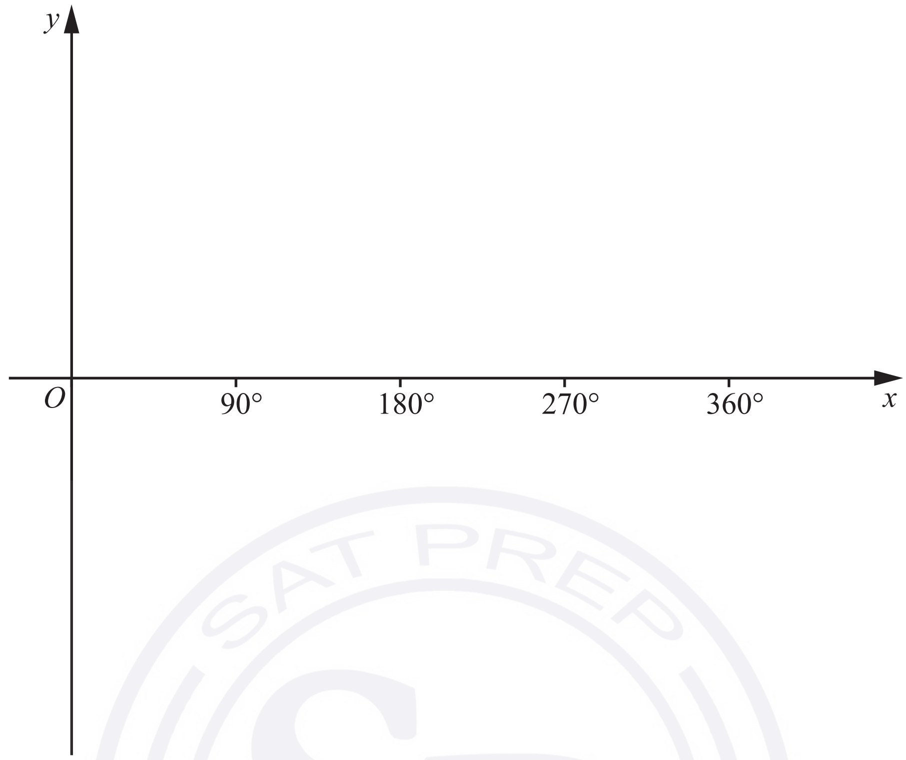
(iii) Find the coordinates of R. [2]

(iv) Find the equation of the line through P, perpendicular to PQ, giving your answer in the form $ax + by = c$, where a, b and c are integers. [3]

(v) Find the coordinates of the midpoint, M, of the line PQ. [2]

(vi) Find the area of triangle QRM. [2]

10 (a) The function f is defined by $\mathrm{f}: x \mapsto |\sin x|$ for $0° \leqslant x \leqslant 360°$. On the axes below, sketch the graph of $y = \mathrm{f}(x)$. [2]

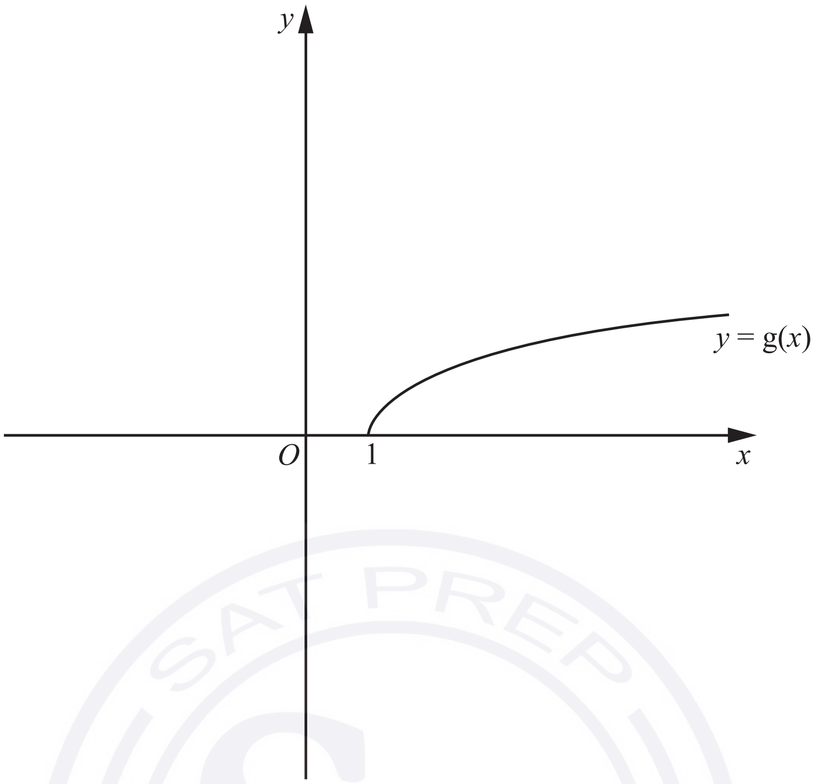


(b) The functions g and hg are defined, for $x \geqslant 1$, by

$$\mathrm{g}(x) = \ln(4x - 3),$$
$$\mathrm{hg}(x) = x.$$

(i) Show that $\mathrm{h}(x) = \dfrac{\mathrm{e}^x + 3}{4}$. [2]

(ii)



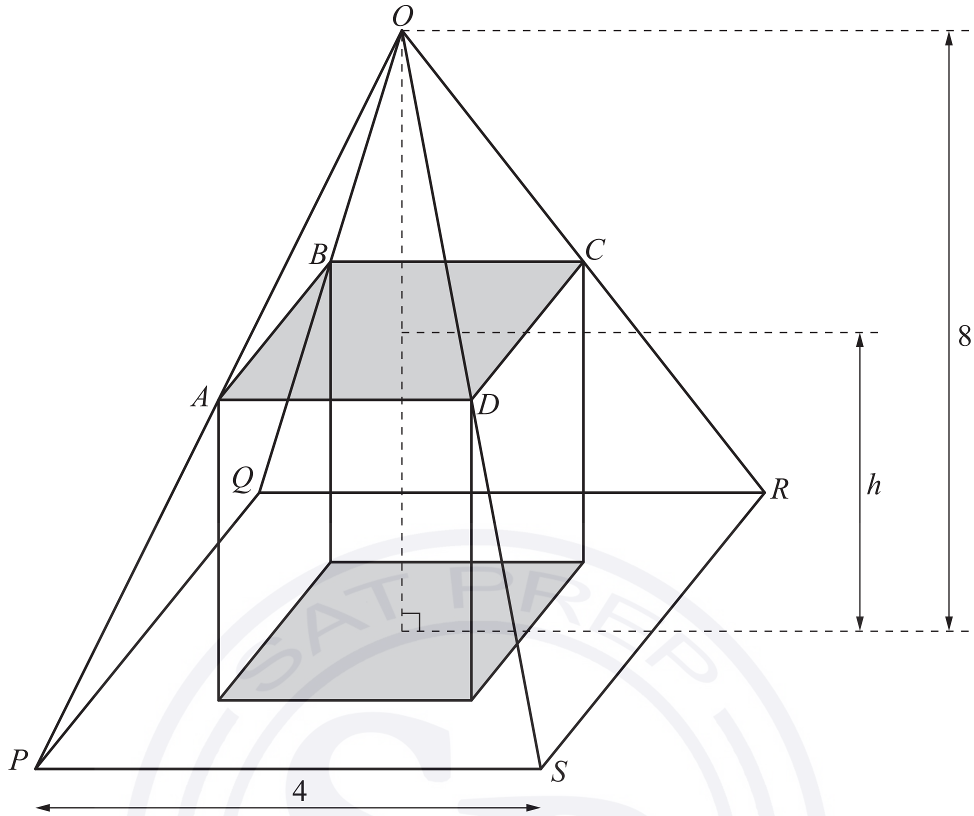
The diagram shows the graph of $y = \mathrm{g}(x)$. Given that g and h are inverse functions, sketch, on the same diagram, the graph of $y = \mathrm{h}(x)$. Give the coordinates of any point where your graph meets the coordinate axes. [2]

(iii) State the domain of h. [1]

(iv) State the range of h. [1]

[Turn over

11



The diagram shows a cuboid of height h units inside a right pyramid $OPQRS$ of height 8 units and with square base of side 4 units. The base of the cuboid sits on the square base $PQRS$ of the pyramid. The points A, B, C and D are corners of the cuboid and lie on the edges OP, OQ, OR and OS, respectively, of the pyramid $OPQRS$. The pyramids $OPQRS$ and $OABCD$ are similar.

(i) Find an expression for AD in terms of h and hence show that the volume V of the cuboid is given by $V = \dfrac{h^3}{4} - 4h^2 + 16h$ units^3. [4]

(ii) Given that h can vary, find the value of h for which V is a maximum. [4]

Question 12 is printed on the next page.

12 **(i)** Show that $x = -2$ is a root of the polynomial equation $15x^3 + 26x^2 - 11x - 6 = 0$. [1]

(ii) Find the remainder when $15x^3 + 26x^2 - 11x - 6$ is divided by $x - 3$. [2]

(iii) Find the value of p and of q such that $15x^3 + 26x^2 - 11x - 6$ is a factor of $15x^4 + px^3 - 37x^2 + qx + 6$. [4]

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

5788775707

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2015**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

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The total number of marks for this paper is 80.

This document consists of **15** printed pages and **1** blank page.

DC (NF/SW) 105994

CAMBRIDGE International Examinations

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

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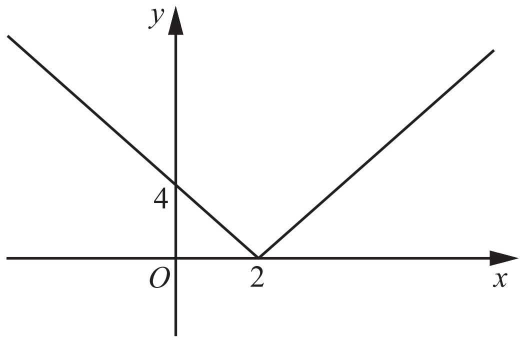
1 **(a)** Write $\log_{27}x$ as a logarithm to base 3. [2]

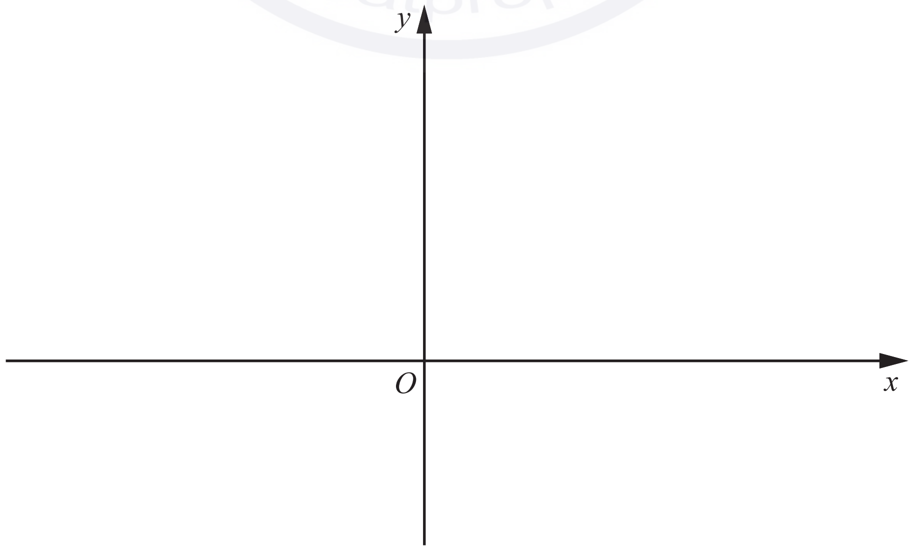
(b) Given that $\log_a y = 3(\log_a 15 - \log_a 3) + 1$, express y in terms of a. [3]

2 **(a)**



The diagram shows the graph of $y = |f(x)|$ passing through $(0, 4)$ and touching the x-axis at $(2, 0)$. Given that the graph of $y = f(x)$ is a straight line, write down the two possible expressions for $f(x)$. [2]

(b) On the axes below, sketch the graph of $y = e^{-x} + 3$, stating the coordinates of any point of intersection with the coordinate axes. [3]



3 **(a)** Find the matrix **A** if $4\mathbf{A} + 5\begin{pmatrix} 4 & 0 & -1 \\ 3 & -2 & 5 \end{pmatrix} = \begin{pmatrix} 52 & -8 & 19 \\ 31 & 2 & 65 \end{pmatrix}$. [2]

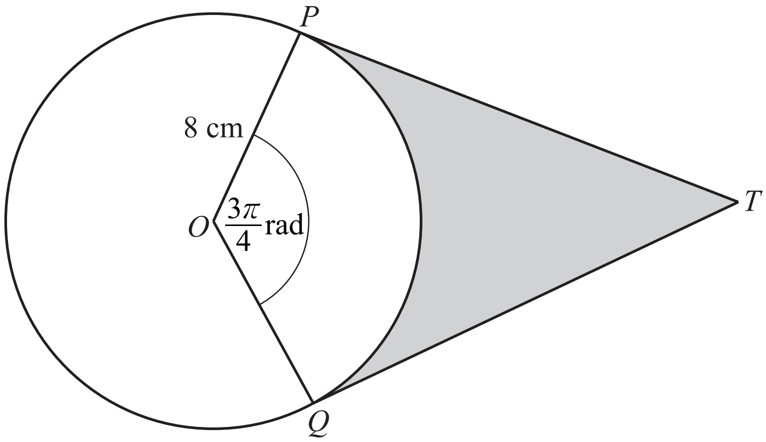
(b) $$\mathbf{P} = \begin{pmatrix} 30 & 25 & 65 \\ 70 & 15 & 80 \\ 50 & 40 & 30 \\ 40 & 20 & 75 \end{pmatrix} \qquad \mathbf{Q} = \begin{pmatrix} 650 & 500 & 450 & 225 \end{pmatrix}$$

The matrix **P** represents the number of 4 different televisions that are on sale in each of 3 shops. The matrix **Q** represents the value of each television in dollars.

(i) State, without evaluation, what is represented by the matrix **QP**. [1]

(ii) Given that the matrix $\mathbf{R} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$, state, without evaluation, what is represented by the matrix **QPR**. [1]

4



The diagram shows a circle, centre O, radius 8 cm. The points P and Q lie on the circle. The lines PT and QT are tangents to the circle and angle $POQ = \frac{3\pi}{4}$ radians.

(i) Find the length of PT. [2]

(ii) Find the area of the shaded region. [3]

(iii) Find the perimeter of the shaded region. [2]

5 **(a)** A lock can be opened using only the number 4351. State whether this is a permutation or a combination of digits, giving a reason for your answer. [1]

(b) There are twenty numbered balls in a bag. Two of the balls are numbered 0, six are numbered 1, five are numbered 2 and seven are numbered 3, as shown in the table below.

Number on ball	0	1	2	3
Frequency	2	6	5	7

Four of these balls are chosen at random, without replacement. Calculate the number of ways this can be done so that

(i) the four balls all have the same number, [2]

(ii) the four balls all have different numbers, [2]

(iii) the four balls have numbers that total 3. [3]

6 A particle P is projected from the origin O so that it moves in a straight line. At time t seconds after projection, the velocity of the particle, v ms^{-1}, is given by $v = 2t^2 - 14t + 12$.

(i) Find the time at which P first comes to instantaneous rest. [2]

(ii) Find an expression for the displacement of P from O at time t seconds. [3]

(iii) Find the acceleration of P when $t = 3$. [2]

7 **(a)** The four points O, A, B and C are such that

$$\overrightarrow{OA} = 5\mathbf{a}, \qquad \overrightarrow{OB} = 15\mathbf{b}, \qquad \overrightarrow{OC} = 24\mathbf{b} - 3\mathbf{a}.$$

Show that B lies on the line AC. [3]

(b) Relative to an origin O, the position vector of the point P is $\mathbf{i} - 4\mathbf{j}$ and the position vector of the point Q is $3\mathbf{i} + 7\mathbf{j}$. Find

(i) $|\overrightarrow{PQ}|$, [2]

(ii) the unit vector in the direction $\overrightarrow{PQ}$, [1]

(iii) the position vector of M, the mid-point of PQ. [2]

8 **(a)** **(i)** Find $\int e^{4x+3}\,dx$. [2]

(ii) Hence evaluate $\int_{2.5}^{3} e^{4x+3}\,dx$. [2]

(b) **(i)** Find $\int \cos\left(\frac{x}{3}\right)dx$. [2]

(ii) Hence evaluate $\int_{0}^{\frac{\pi}{6}} \cos\left(\frac{x}{3}\right)dx$. [2]

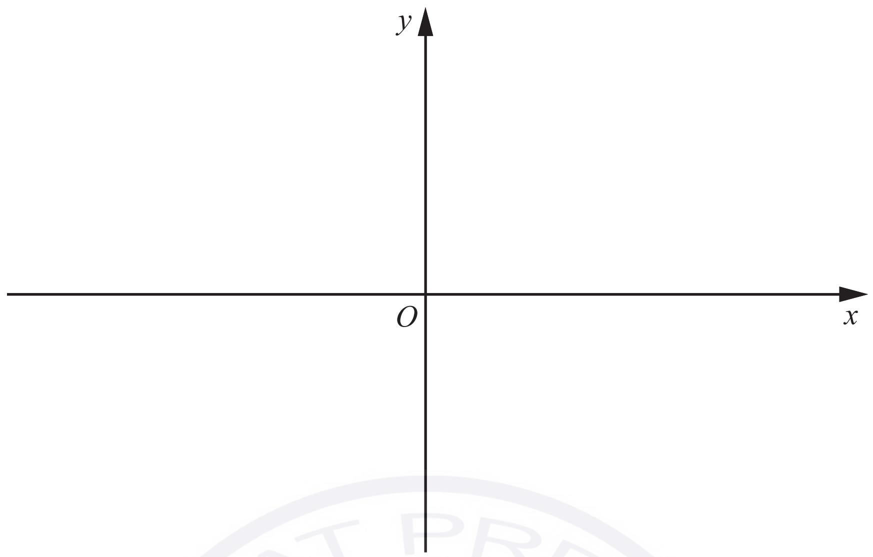
(c) Find $\int (x^{-1} + x)^2 \, dx$. [4]

9 **(a)** Find the set of values of x for which $4x^2 + 19x - 5 \leqslant 0$. [3]

(b) **(i)** Express $x^2 + 8x - 9$ in the form $(x + a)^2 + b$, where a and b are integers. [2]

(ii) Use your answer to part **(i)** to find the greatest value of $9 - 8x - x^2$ and the value of x at which this occurs. [2]

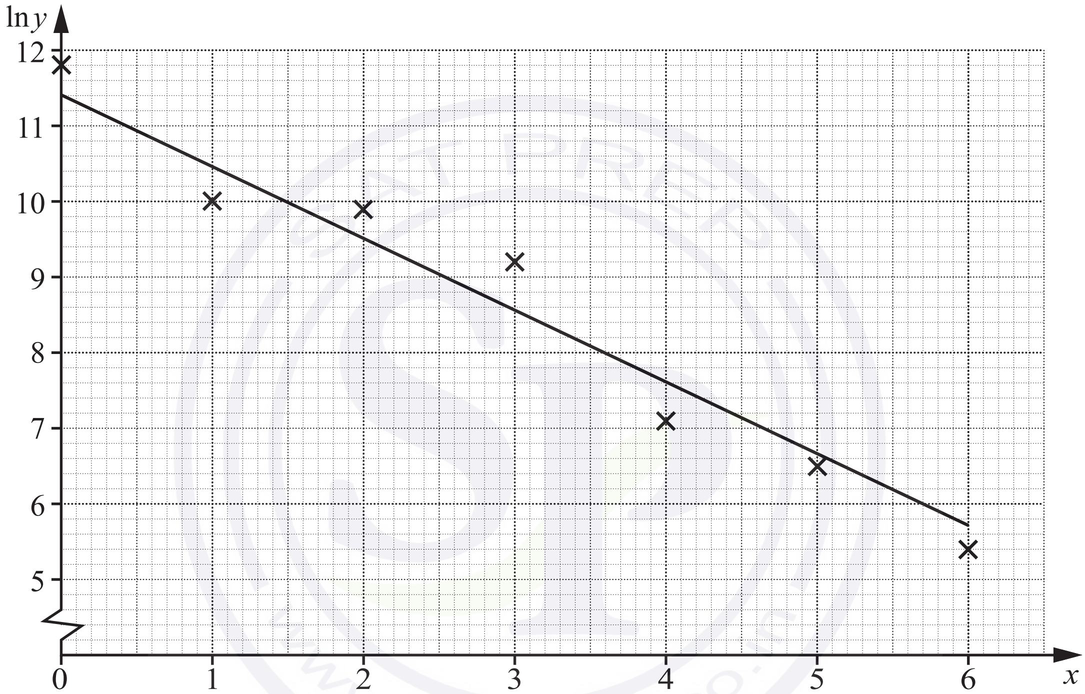
(iii) Sketch the graph of $y = 9 - 8x - x^2$, indicating the coordinates of any points of intersection with the coordinate axes. [2]



10 The relationship between experimental values of two variables, x and y, is given by $y = Ab^x$, where A and b are constants.

(i) By transforming the relationship $y = Ab^x$, show that plotting $\ln y$ against x should produce a straight line graph. [2]

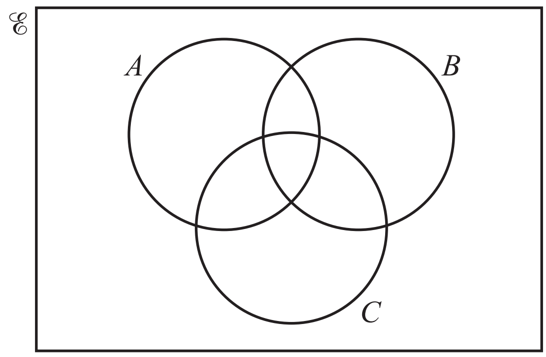
(ii) The diagram below shows the results of plotting $\ln y$ against x for 7 different pairs of values of variables, x and y. A line of best fit has been drawn.



By taking readings from the diagram, find the value of A and of b, giving each value correct to 1 significant figure. [4]

(iii) Estimate the value of y when $x = 2.5$. [2]

11



The Venn diagram above shows the sets A, B and C. It is given that

$n(A \cup B \cup C) = 48,$

$n(A) = 30, \quad n(B) = 25, \quad n(C) = 15,$

$n(A \cap B) = 7, \quad n(B \cap C) = 6, \quad n(A' \cap B \cap C') = 16.$

(i) Find the value of x, where $x = n(A \cap B \cap C)$. [3]

(ii) Find the value of y, where $y = n(A \cap B' \cap C)$. [3]

(iii) Hence show that $A' \cap B' \cap C = \varnothing$. [1]

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

8475148912

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **February/March 2015**

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.
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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.

DC (AC/FD) 99297/4

CAMBRIDGE
International Examinations

[Turn over

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

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

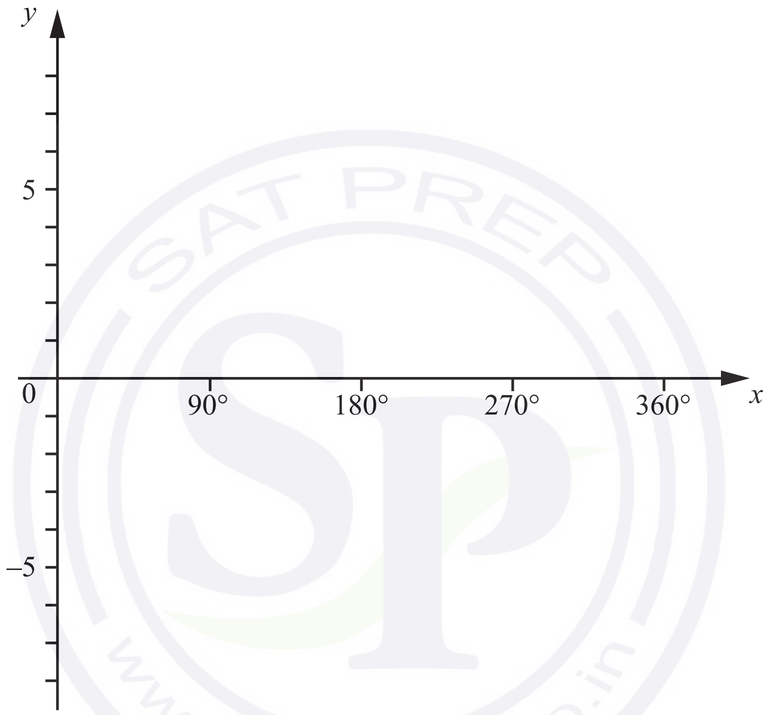
$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

1 **(i)** State the amplitude of $4\cos x - 3$. [1]

(ii) State the period of $4\cos x - 3$. [1]

(iii) The function f is defined, for $0° \leqslant x \leqslant 360°$, by $f(x) = 4\cos x - 3$. Sketch the graph of $y = f(x)$ on the axes below. [2]



2 **(a)** Jean has nine different flags.

(i) Find the number of different ways in which Jean can choose three flags from her nine flags. [1]

(ii) Jean has five flagpoles in a row. She puts one of her nine flags on each flagpole. Calculate the number of different five-flag arrangements she can make. [1]

(b) The six digits of the number 738925 are rearranged so that the resulting six-digit number is even. Find the number of different ways in which this can be done. [2]

3 Solve the simultaneous equations

$$3x^2 - xy + 2y^2 = 16,$$
$$2y - x = 4.$$

[5]

4 **(i)** Differentiate $\sin x \cos x$ with respect to x, giving your answer in terms of $\sin x$. [3]

(ii) Hence find $\int \sin^2 x \, dx$. [3]

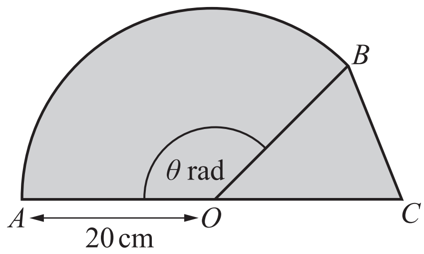
5 The position vectors of the points A and B relative to an origin O are $-2\mathbf{i} + 17\mathbf{j}$ and $6\mathbf{i} + 2\mathbf{j}$ respectively.

(i) Find the vector $\overrightarrow{AB}$. [1]

(ii) Find the unit vector in the direction of $\overrightarrow{AB}$. [2]

(iii) The position vector of the point C relative to the origin O is such that $\overrightarrow{OC} = \overrightarrow{OA} + m\overrightarrow{OB}$, where m is a constant. Given that C lies on the x-axis, find the vector $\overrightarrow{OC}$. [3]

6



AOB is a sector of a circle with centre O and radius 20 cm. Angle $AOB = \theta$ radians. AOC is a straight line and triangle OBC is isosceles with $OB = OC$.

(i) Given that the length of the arc AB is 15π cm, find the exact value of θ. [2]

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

7 It is given that $\mathbf{A} = \begin{pmatrix} -1 & 5 \\ -3 & 10 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 3 & 5 \\ 4 & 10 \end{pmatrix}$.

(i) Find $\mathbf{A}^2 + \mathbf{B}$. [2]

(ii) Find det $\mathbf{B}$. [1]

(iii) Find the inverse matrix, $\mathbf{B}^{-1}$. [2]

(iv) Find the matrix $\mathbf{X}$, given that $\mathbf{BX} = \mathbf{A}$. [2]

8 Solutions to this question by accurate drawing will not be accepted.

The points A and B have coordinates $(2, -1)$ and $(6, 5)$ respectively.

(i) Find the equation of the perpendicular bisector of AB, giving your answer in the form $ax + by = c$, where a, b and c are integers. [4]

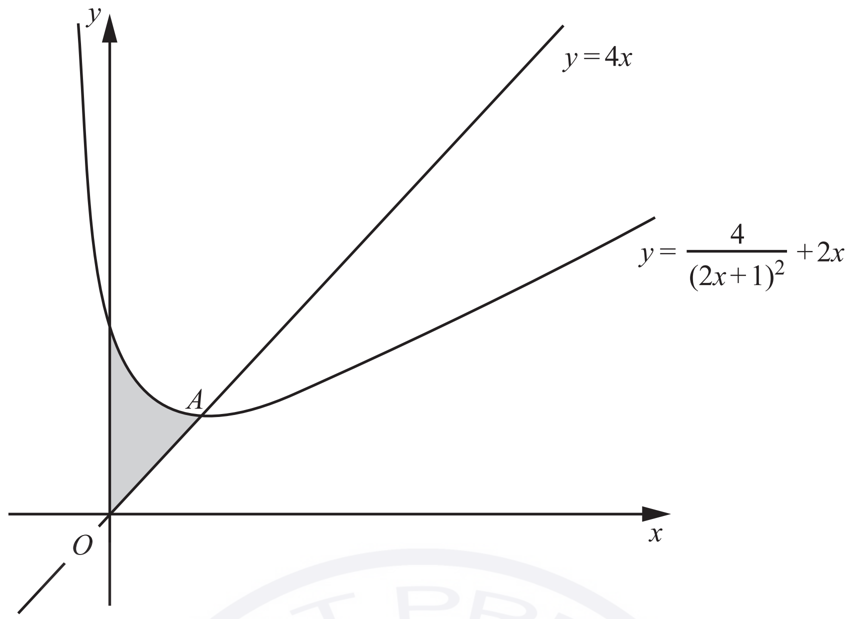
The point C has coordinates $(10, -2)$.

(ii) Find the equation of the line through C which is parallel to AB. [2]

(iii) Calculate the length of *BC*. [2]

(iv) Show that triangle *ABC* is isosceles. [1]

9



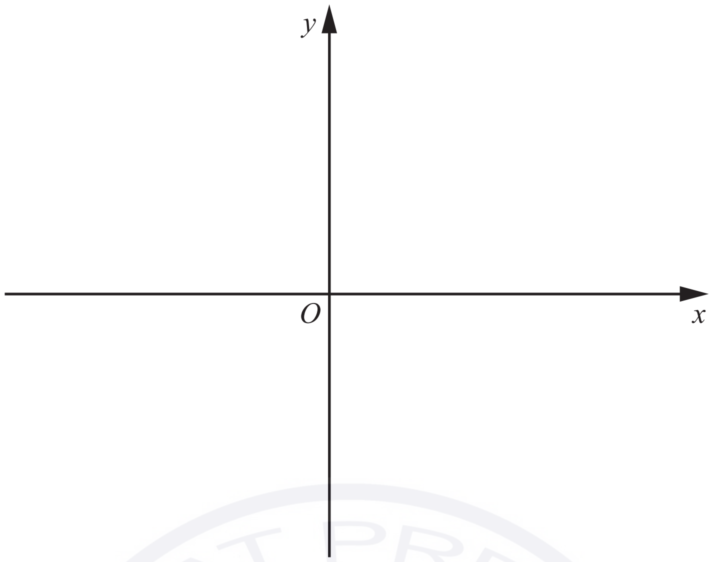
The diagram shows part of the curve $y = \dfrac{4}{(2x+1)^2} + 2x$ and the line $y = 4x$.

(i) Find the coordinates of A, the stationary point of the curve. [5]

(ii) Verify that A is also the point of intersection of the curve $y = \dfrac{4}{(2x+1)^2} + 2x$ and the line $y = 4x$. [1]

(iii) **Without using a calculator**, find the area of the shaded region enclosed by the line $y = 4x$, the curve and the y-axis. [6]

10 **(a)** **(i)** Sketch the graph of $y = \mathrm{e}^{x} - 5$ on the axes below, showing the exact coordinates of any points where the graph meets the coordinate axes. [3]



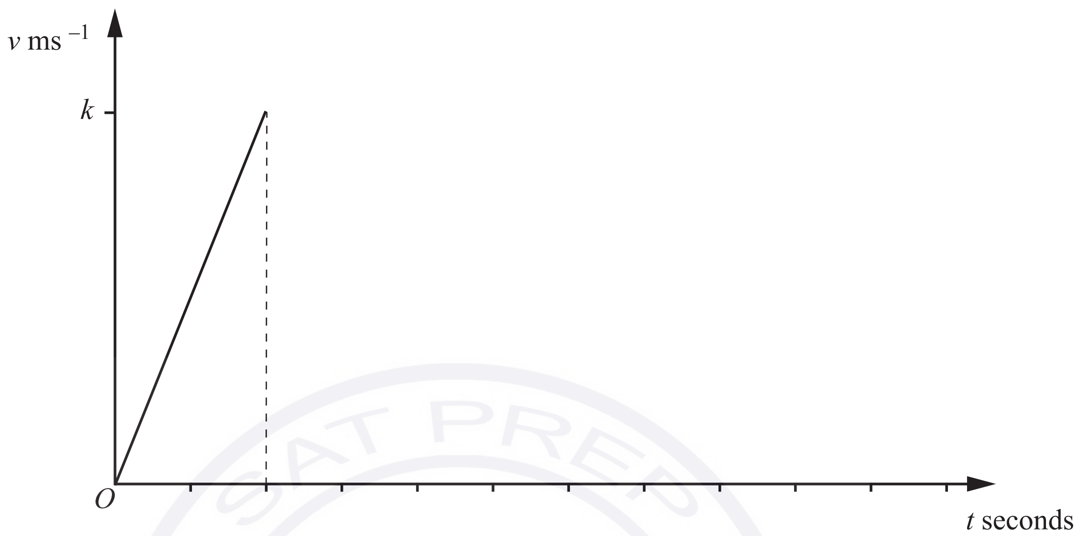
(ii) Find the range of values of k for which the equation $\mathrm{e}^{x} - 5 = k$ has no solutions. [1]

(b) Simplify $\log_a \sqrt{2} + \log_a 8 + \log_a \left(\frac{1}{2}\right)$, giving your answer in the form $p\log_a 2$, where p is a constant. [2]

(c) Solve the equation $\log_3 x - \log_9 4x = 1$. [4]

11 **(a)** A particle P moves in a straight line. Starting from rest, P moves with constant acceleration for 30 seconds after which it moves with constant velocity, $k\,\text{ms}^{-1}$, for 90 seconds. P then moves with constant deceleration until it comes to rest; the magnitude of the deceleration is twice the magnitude of the initial acceleration.

(i) Use the information to complete the velocity-time graph. [2]



(ii) Given that the particle travels 450 metres while it is accelerating, find the value of k and the acceleration of the particle. [4]

Question 11(b) is printed on the next page.

(b) A body Q moves in a straight line such that, t seconds after passing a fixed point, its acceleration, $a\,\text{ms}^{-2}$, is given by $a = 3t^2 + 6$. When $t = 0$, the velocity of the body is $5\,\text{ms}^{-1}$. Find the velocity when $t = 3$. [5]

Cambridge IGCSE

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Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

9585800326

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2014**

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.
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This document consists of **15** printed pages and **1** blank page.

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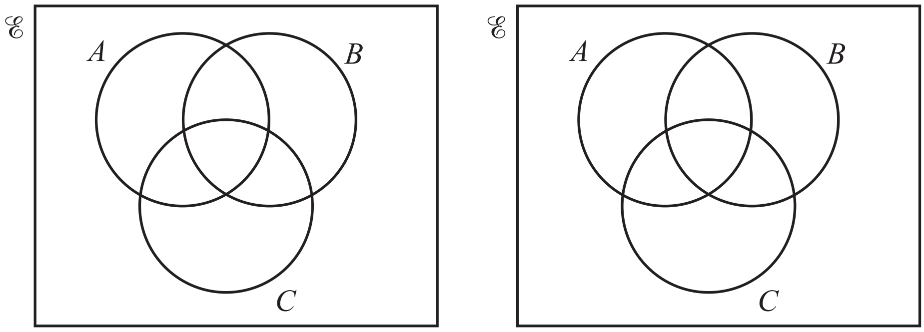
1 **(a)** On each of the Venn diagrams below shade the region which represents the given set.



$(A \cap B) \cup C'$ $\qquad\qquad$ $A' \cap (B \cup C)$ [2]

(b) In a year group of 98 pupils, F is the set of pupils who play football and H is the set of pupils who play hockey. There are 60 pupils who play football and 50 pupils who play hockey. The number that play both sports is x and the number that play neither is $30 - 2x$. Find the value of x. [3]

2 Solve the inequality $9x^2 + 2x - 1 < (x+1)^2$. [3]

---

3 Solve the following simultaneous equations.

$$\log_2(x+3) = 2 + \log_2 y$$

$$\log_2(x+y) = 3$$ [5]

4 The functions f and g are defined for real values of x by

$$f(x) = \sqrt{x-1} - 3 \qquad \text{for } x > 1,$$

$$g(x) = \frac{x-2}{2x-3} \qquad \text{for } x > 2.$$

(i) Find gf(37). [2]

(ii) Find an expression for $f^{-1}(x)$. [2]

(iii) Find an expression for $g^{-1}(x)$. [2]

5 The number of bacteria B in a culture, t days after the first observation, is given by

$$B = 500 + 400e^{0.2t}.$$

(i) Find the initial number present. [1]

(ii) Find the number present after 10 days. [1]

(iii) Find the rate at which the bacteria are increasing after 10 days. [2]

(iv) Find the value of t when $B = 10\,000$. [3]

6 **(i)** Calculate the coordinates of the points where the line $y = x + 2$ cuts the curve $x^2 + y^2 = 10$. [4]

(ii) Find the exact values of m for which the line $y = mx + 5$ is a tangent to the curve $x^2 + y^2 = 10$. [4]

7 A particle moving in a straight line passes through a fixed point O. The displacement, x metres, of the particle, t seconds after it passes through O, is given by $x = t + 2\sin t$.

(i) Find an expression for the velocity, $v\,\mathrm{ms}^{-1}$, at time t. [2]

When the particle is first at instantaneous rest, find

(ii) the value of t, [2]

(iii) its displacement and acceleration. [3]

8 **(i)** Given that $y = \dfrac{x^2}{2 + x^2}$, show that $\dfrac{dy}{dx} = \dfrac{kx}{(2 + x^2)^2}$, where k is a constant to be found. [3]

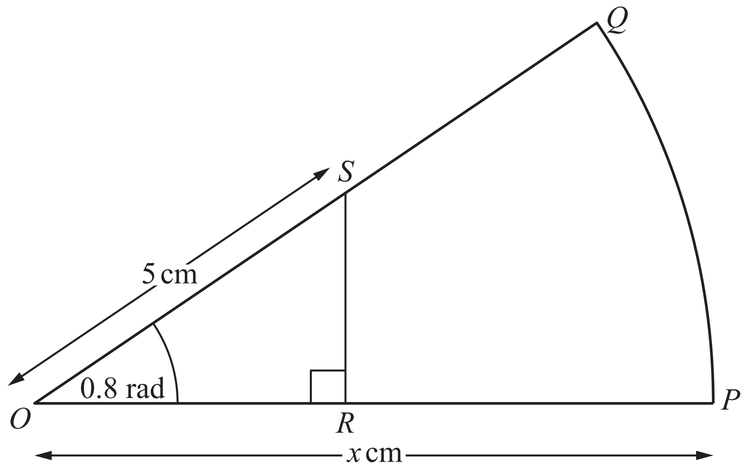
(ii) Hence find $\displaystyle\int \frac{x}{(2 + x^2)^2}\,dx$. [2]

9 Integers a and b are such that $(a+3\sqrt{5})^2+a-b\sqrt{5}=51$. Find the possible values of a and the corresponding values of b. [6]

10 **(i)** Prove that $\sec x \operatorname{cosec} x - \cot x = \tan x$. [4]

(ii) Use the result from part **(i)** to solve the equation $\sec x \operatorname{cosec} x = 3\cot x$ for $0° < x < 360°$. [4]

11



The diagram shows a sector OPQ of a circle with centre O and radius x cm. Angle POQ is 0.8 radians. The point S lies on OQ such that $OS = 5$ cm. The point R lies on OP such that angle ORS is a right angle. Given that the area of triangle ORS is one-fifth of the area of sector OPQ, find

(i) the area of sector OPQ in terms of x and hence show that the value of x is 8.837 correct to 4 significant figures, [5]

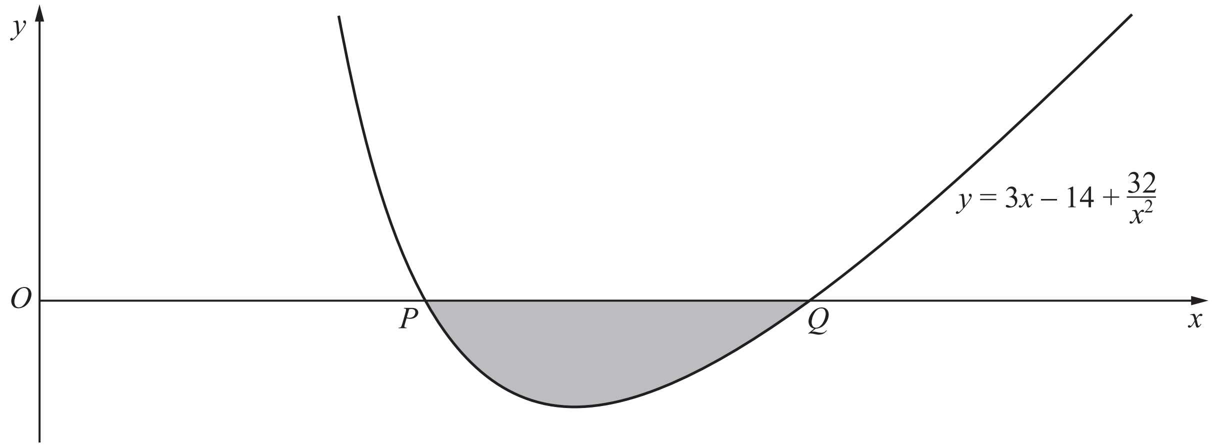
(ii) the perimeter of *PQSR*, [3]

(iii) the area of *PQSR*. [2]

12 **(i)** Show that $x-2$ is a factor of $3x^3 - 14x^2 + 32$. [1]

(ii) Hence factorise $3x^3 - 14x^2 + 32$ completely. [4]

The diagram below shows part of the curve $y = 3x - 14 + \frac{32}{x^2}$ cutting the x-axis at the points P and Q.



(iii) State the x-coordinates of P and Q. [1]

(iv) Find $\int \left(3x - 14 + \frac{32}{x^2}\right) dx$ and hence determine the area of the shaded region. [4]

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Cambridge International Examinations
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CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

4993197969

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **October/November 2014**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

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CAMBRIDGE International Examinations

[Turn over

Mathematical Formulae

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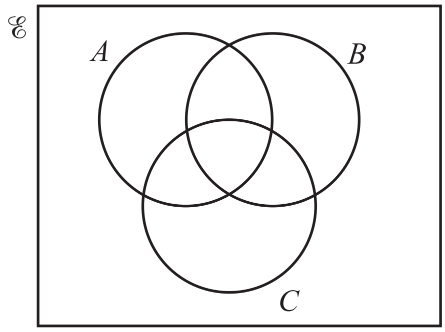
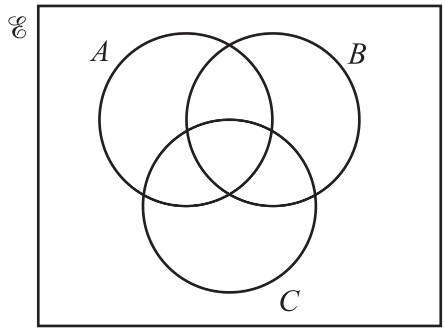


$(A \cap B) \cup C'$



$A' \cap (B \cup C)$ [2]

(b) In a year group of 98 pupils, F is the set of pupils who play football and H is the set of pupils who play hockey. There are 60 pupils who play football and 50 pupils who play hockey. The number that play both sports is x and the number that play neither is $30 - 2x$. Find the value of x. [3]

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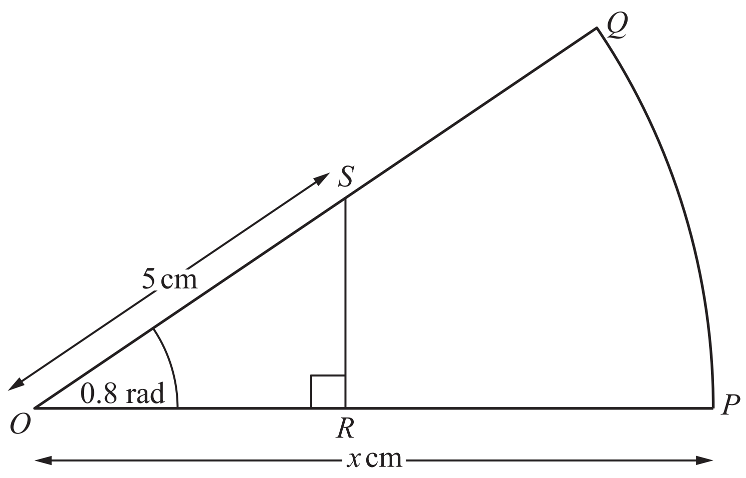
11



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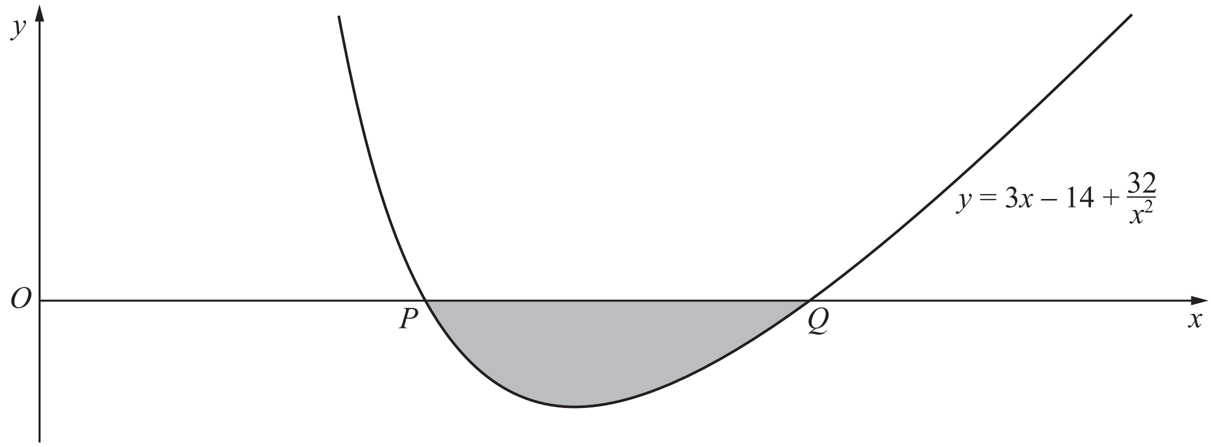
(ii) the perimeter of *PQSR*, [3]

(iii) the area of *PQSR*. [2]

12 **(i)** Show that $x - 2$ is a factor of $3x^3 - 14x^2 + 32$. [1]

(ii) Hence factorise $3x^3 - 14x^2 + 32$ completely. [4]

The diagram below shows part of the curve $y = 3x - 14 + \frac{32}{x^2}$ cutting the x-axis at the points P and Q.



(iii) State the x-coordinates of P and Q. [1]

(iv) Find $\int (3x - 14 + \frac{32}{x^2})\,dx$ and hence determine the area of the shaded region. [4]

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Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

2249239059

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2014**

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.
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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.

DC (NF/SLM) 81812/2

CAMBRIDGE
International Examinations

[Turn over

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 The expression $f(x) = 3x^3 + 8x^2 - 33x + p$ has a factor of $x - 2$.

(i) Show that $p = 10$ and express $f(x)$ as a product of a linear factor and a quadratic factor. [4]

(ii) Hence solve the equation $f(x) = 0$. [2]

2 A committee of four is to be selected from 7 men and 5 women. Find the number of different committees that could be selected if

(i) there are no restrictions, [1]

(ii) there must be two male and two female members. [2]

A brother and sister, Ken and Betty, are among the 7 men and 5 women.

(iii) Find how many different committees of four could be selected so that there are two male and two female members which must include either Ken or Betty but not both. [4]

3 Points A and B have coordinates $(-2, 10)$ and $(4, 2)$ respectively. C is the mid-point of the line AB. Point D is such that $\overrightarrow{CD} = \begin{pmatrix} 12 \\ 9 \end{pmatrix}$.

(i) Find the coordinates of C and of D. [3]

(ii) Show that CD is perpendicular to AB. [3]

(iii) Find the area of triangle ABD. [2]

4 The profit $$P$ made by a company in its nth year is modelled by

$$P = 1000e^{an+b}.$$

In the first year the company made $2000 profit.

(i) Show that $a + b = \ln 2$. [1]

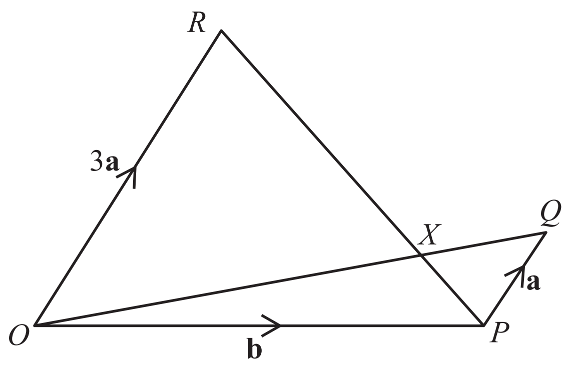
In the second year the company made $3297 profit.

(ii) Find another linear equation connecting a and b. [2]

(iii) Solve the two equations from parts **(i)** and **(ii)** to find the value of a and of b. [2]

(iv) Using your values for a and b, find the profit in the 10th year. [2]

5



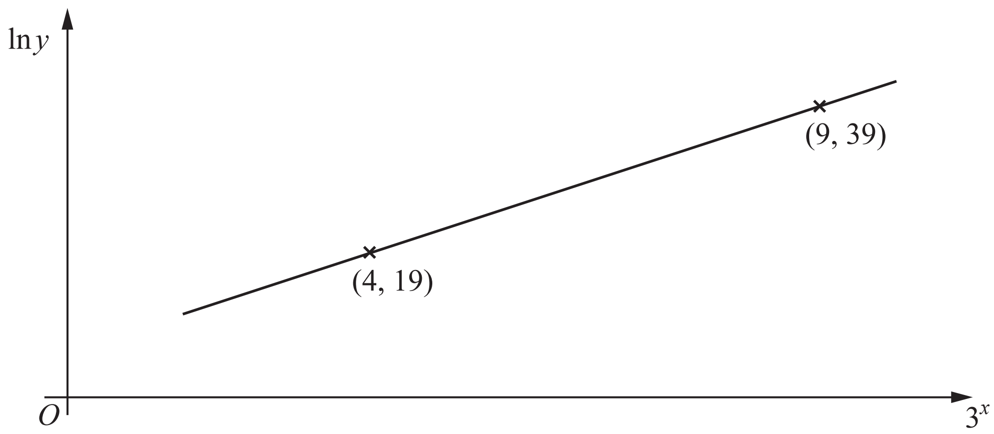
In the diagram $\overrightarrow{OP} = \mathbf{b}$, $\overrightarrow{PQ} = \mathbf{a}$ and $\overrightarrow{OR} = 3\mathbf{a}$. The lines OQ and PR intersect at X.

(i) Given that $\overrightarrow{OX} = \mu\overrightarrow{OQ}$, express $\overrightarrow{OX}$ in terms of μ, $\mathbf{a}$ and $\mathbf{b}$. [1]

(ii) Given that $\overrightarrow{RX} = \lambda\overrightarrow{RP}$, express $\overrightarrow{OX}$ in terms of λ, $\mathbf{a}$ and $\mathbf{b}$. [2]

(iii) Hence find the value of μ and of λ and state the value of the ratio $\dfrac{RX}{XP}$. [3]

6 Variables x and y are such that, when $\ln y$ is plotted against 3^x, a straight line graph passing through (4, 19) and (9, 39) is obtained.



(i) Find the equation of this line in the form $\ln y = m3^x + c$, where m and c are constants to be found. [3]

(ii) Find y when $x = 0.5$. [2]

(iii) Find x when $y = 2000$. [3]

7 The functions f and g are defined for real values of x by

$$f(x) = \frac{2}{x} + 1 \text{ for } x > 1,$$

$$g(x) = x^2 + 2.$$

Find an expression for

(i) $f^{-1}(x)$, [2]

(ii) $gf(x)$, [2]

(iii) $fg(x)$. [2]

(iv) Show that $\mathrm{ff}(x) = \dfrac{3x+2}{x+2}$ and solve $\mathrm{ff}(x) = x$. [4]

8 A particle moving in a straight line passes through a fixed point O. The displacement, x metres, of the particle, t seconds after it passes through O, is given by $x = 5t - 3\cos 2t + 3$.

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

(ii) Find the maximum velocity of the particle and the value of t at which this first occurs. [3]

(iii) Find the value of t when the velocity of the particle is first equal to $2\,\text{ms}^{-1}$ and its acceleration at this time**.** [3]

9 **(i)** Determine the coordinates and nature of each of the two turning points on the curve $y = 4x + \dfrac{1}{x-2}$. [6]

(ii) Find the equation of the normal to the curve at the point (3, 13) and find the x-coordinate of the point where this normal cuts the curve again. [6]

10 **(i)** Prove that $\dfrac{1}{1-\cos x}+\dfrac{1}{1+\cos x}=2\operatorname{cosec}^2 x.$ [3]

(ii) Hence solve the equation $\dfrac{1}{1-\cos x}+\dfrac{1}{1+\cos x}=8$ for $0° < x < 360°$. [4]

Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

8652224751

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2014**

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 **15** printed pages and **1** blank page.

DC (RW/SW) 73390/3

CAMBRIDGE
International Examinations

[Turn over

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

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

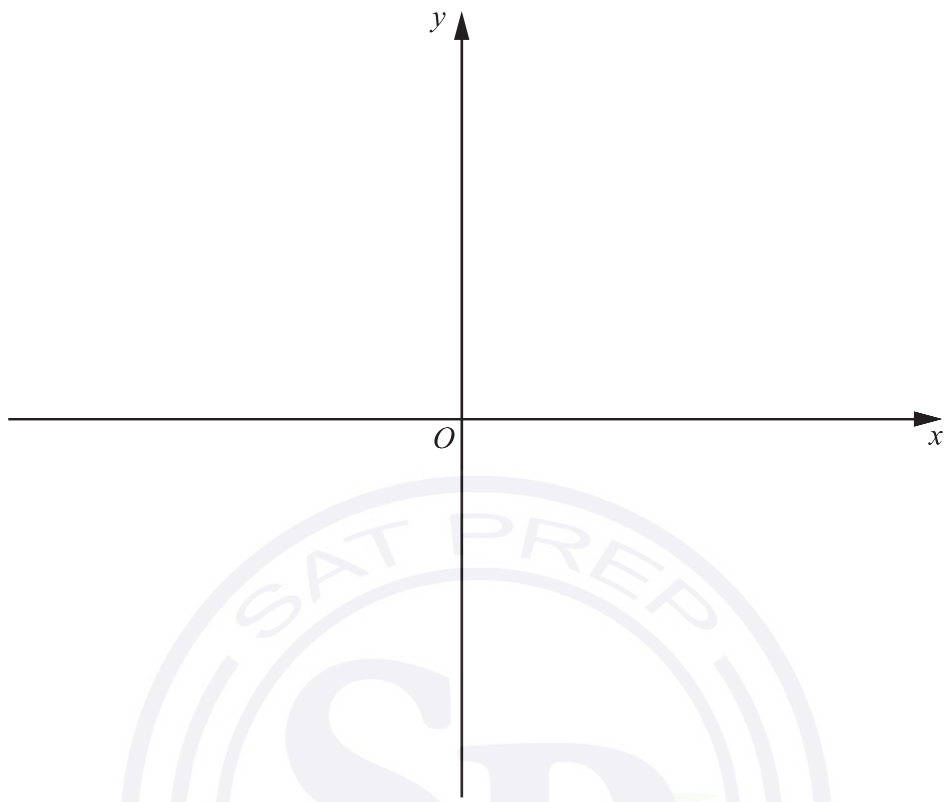
$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

1 Find the set of values of x for which $x(x+2) < x$. [3]

2 **Without using a calculator**, express $6(1+\sqrt{3})^{-2}$ in the form $a + b\sqrt{3}$, where a and b are integers to be found. [4]

3 **(i)** On the axes below, sketch the graph of $y = |(x-4)(x+2)|$ showing the coordinates of the points where the curve meets the x-axis. [2]



(ii) Find the set of values of k for which $|(x-4)(x+2)| = k$ has four solutions. [3]

4 The expression $2x^3 + ax^2 + bx + 12$ has a factor $x - 4$ and leaves a remainder of -12 when divided by $x - 1$. Find the value of each of the constants a and b. [5]

5 **(i)** Express $2x^2 - x + 6$ in the form $p(x-q)^2 + r$, where p, q and r are constants to be found. [3]

(ii) Hence state the least value of $2x^2 - x + 6$ and the value of x at which this occurs. [2]

6 **(a)** Find the coefficient of x^5 in the expansion of $(3-2x)^8$. [2]

(b) **(i)** Write down the first three terms in the expansion of $(1+2x)^6$ in ascending powers of x. [2]

(ii) In the expansion of $(1+ax)(1+2x)^6$, the coefficient of x^2 is 1.5 times the coefficient of x. Find the value of the constant a. [4]

7 Given that a curve has equation $y = \frac{1}{x} + 2\sqrt{x}$, where $x > 0$, find

(i) $\frac{dy}{dx}$, [2]

(ii) $\frac{d^2y}{dx^2}$. [2]

Hence, or otherwise, find

(iii) the coordinates and nature of the stationary point of the curve. [4]

8 A sector of a circle of radius r cm has an angle of θ radians, where $\theta < \pi$. The perimeter of the sector is 30 cm.

(i) Show that the area, A cm^2, of the sector is given by $A = 15r - r^2$. [3]

(ii) Given that r can vary, find the maximum area of the sector. [3]

9 Solutions to this question by accurate drawing will not be accepted.

The points $A(p,1)$, $B(1,6)$, $C(4,q)$ and $D(5,4)$, where p and q are constants, are the vertices of a kite *ABCD*. The diagonals of the kite, *AC* and *BD*, intersect at the point *E*. The line *AC* is the perpendicular bisector of *BD*. Find

(i) the coordinates of *E*, [2]

(ii) the equation of the diagonal *AC*, [3]

(iii) the area of the kite *ABCD*. [3]

10 Find $\frac{\mathrm{d}y}{\mathrm{d}x}$ when

(i) $y = \cos 2x \sin\left(\frac{x}{3}\right)$, [4]

(ii) $y = \frac{\tan x}{1 + \ln x}$. [4]

11 **(a)** Solve $2^{x^2-5x}=\frac{1}{64}$. [4]

(b) By changing the base of $\log_{2a}4$, express $(\log_{2a}4)(1+\log_a 2)$ as a single logarithm to base a. [4]

12 The functions f and g are defined by

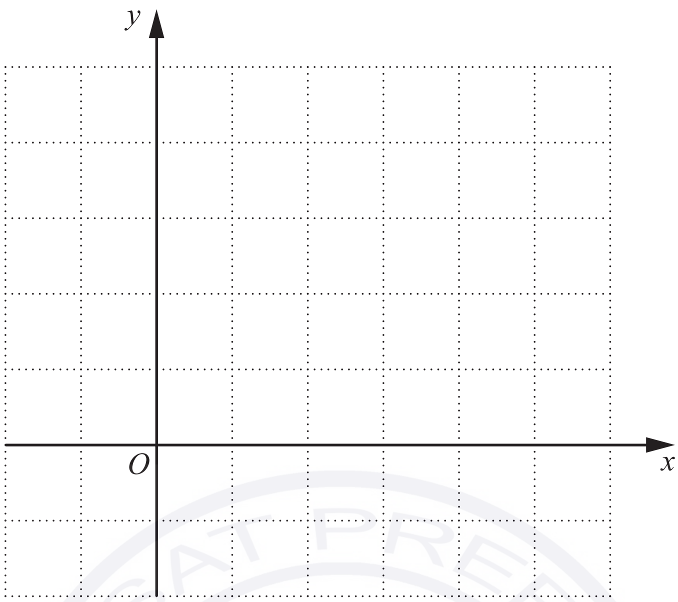
$$f(x) = \frac{2x}{x+1} \text{ for } x > 0,$$
$$g(x) = \sqrt{x+1} \text{ for } x > -1.$$

(i) Find fg(8). [2]

(ii) Find an expression for $f^2(x)$, giving your answer in the form $\frac{ax}{bx+c}$, where a, b and c are integers to be found. [3]

(iii) Find an expression for $g^{-1}(x)$, stating its domain and range. [4]

(iv) On the same axes, sketch the graphs of $y = \mathrm{g}(x)$ and $y = \mathrm{g}^{-1}(x)$, indicating the geometrical relationship between the graphs. [3]



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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

7024709238

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2014**

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.
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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 **14** printed pages and **2** blank pages.

DC (NF/SW) 73391/3

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

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

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

1 **Without using a calculator**, express $\dfrac{(2+\sqrt{5})^2}{\sqrt{5}-1}$ in the form $a+b\sqrt{5}$, where a and b are constants to be found. [4]

---

2 Find the values of k for which the line $y+kx-2=0$ is a tangent to the curve $y=2x^2-9x+4$. [5]

3 **(i)** Given that $x + 1$ is a factor of $3x^3 - 14x^2 - 7x + d$, show that $d = 10$. [1]

(ii) Show that $3x^3 - 14x^2 - 7x + 10$ can be written in the form $(x + 1)(ax^2 + bx + c)$, where a, b and c are constants to be found. [2]

(iii) Hence solve the equation $3x^3 - 14x^2 - 7x + 10 = 0$. [2]

4 **(i)** Express $12x^2 - 6x + 5$ in the form $p(x-q)^2 + r$, where p, q and r are constants to be found. [3]

(ii) Hence find the greatest value of $\dfrac{1}{12x^2 - 6x + 5}$ and state the value of x at which this occurs. [2]

5 **(i)** Find and simplify the first three terms of the expansion, in ascending powers of x, of $(1-4x)^5$. [2]

(ii) The first three terms in the expansion of $(1-4x)^5(1+ax+bx^2)$ are $1-23x+222x^2$. Find the value of each of the constants a and b. [4]

6 **(a)** **(i)** State the value of u for which $\lg u = 0$. [1]

(ii) Hence solve $\lg|2x+3| = 0$. [2]

(b) Express $2\log_3 15 - (\log_a 5)(\log_3 a)$, where $a > 1$, as a single logarithm to base 3. [4]

7 Differentiate with respect to x

(i) x^4e^{3x}, [2]

(ii) $\ln(2+\cos x)$, [2]

(iii) $\dfrac{\sin x}{1+\sqrt{x}}$. [3]

8 The line $y = x - 5$ meets the curve $x^2 + y^2 + 2x - 35 = 0$ at the points A and B. Find the exact length of AB. [6]

9 A curve is such that $\frac{dy}{dx} = (2x+1)^{\frac{1}{2}}$. The curve passes through the point (4, 10).

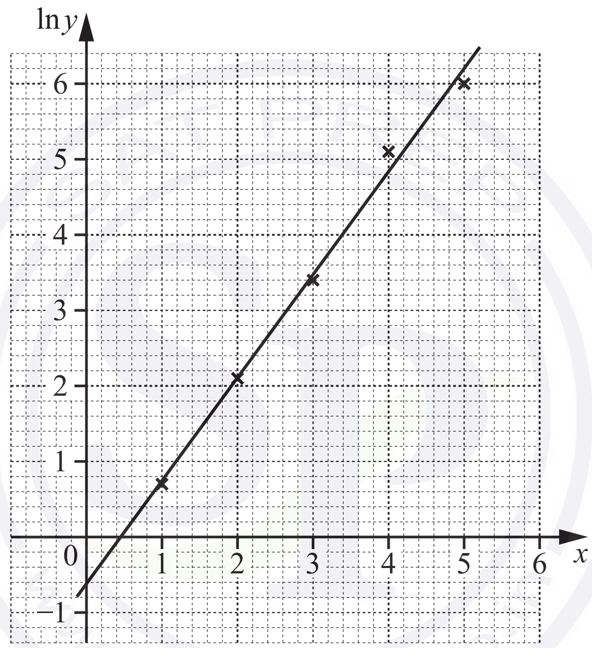
(i) Find the equation of the curve. [4]

(ii) Find $\int y\,dx$ and hence evaluate $\int_0^{1.5} y\,dx$. [5]

10 Two variables x and y are connected by the relationship $y = Ab^x$, where A and b are constants.

(i) Transform the relationship $y = Ab^x$ into a straight line form. [2]

An experiment was carried out measuring values of y for certain values of x. The values of $\ln y$ and x were plotted and a line of best fit was drawn. The graph is shown on the grid below.



(ii) Use the graph to determine the value of A and the value of b, giving each to 1 significant figure. [4]

(iii) Find x when $y = 220$. [2]

11 The functions f and g are defined, for real values of x greater than 2, by

$$f(x) = 2^x - 1,$$
$$g(x) = x(x+1).$$

(i) State the range of f. [1]

(ii) Find an expression for $f^{-1}(x)$, stating its domain and range. [4]

(iii) Find an expression for $gf(x)$ and explain why the equation $gf(x) = 0$ has no solutions. [4]

12 A curve has equation $y = x^3 - 9x^2 + 24x$.

(i) Find the set of values of x for which $\frac{dy}{dx} \geqslant 0$. [4]

The normal to the curve at the point on the curve where $x = 3$ cuts the y-axis at the point P.

(ii) Find the equation of the normal and the coordinates of P. [5]

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

9104538921

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2014**

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.
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The total number of marks for this paper is 80.

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

DC (NH/CGW) 73394/4

CAMBRIDGE International Examinations

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

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

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

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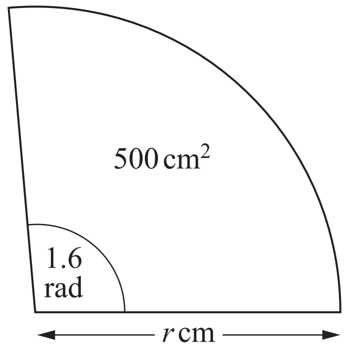
$$a^2 = b^2 + c^2 - 2bc \cos A$$

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

1



The diagram shows a sector of a circle of radius r cm. The angle of the sector is 1.6 radians and the area of the sector is $500\,\text{cm}^2$.

(i) Find the value of r. [2]

(ii) Hence find the perimeter of the sector. [2]

2 Using the substitution $u = \log_3 x$, solve, for x, the equation $\log_3 x - 12\log_x 3 = 4$. [5]

3 In a motor racing competition, the winning driver in each race scores 5 points, the second and third placed drivers score 3 and 1 points respectively. Each team has two members. The results of the drivers in one team, over a number of races, are shown in the table below.

Driver	1^{st} place	2^{nd} place	3^{rd} place
Alan	3	1	4
Brian	1	4	0

(i) Write down two matrices whose product under matrix multiplication will give the number of points scored by each of the drivers. Hence calculate the number of points scored by Alan and by Brian. [3]

(ii) The points scored by Alan and by Brian are added to give the number of points scored by the team. Using your answer to part **(i)**, write down two matrices whose product would give the number of points scored by the team. [1]

4 **(a)** Illustrate the following statements using the Venn diagrams below.

(i) $A \cup B = A$ **(ii)** $A \cap B \cap C = \varnothing$ [2]

ℰ ℰ

(b) It is given that ℰ is the set of integers between 1 and 100 inclusive. S and C are subsets of ℰ, where S is the set of square numbers and C is the set of cube numbers. Write the following statements using set notation.

(i) 50 is not a cube number. [1]

(ii) 64 is both a square number and a cube number. [1]

(iii) There are 90 integers between 1 and 100 inclusive which are not square numbers. [1]

5 Do not use a calculator in this question.

(i) Show that $(2\sqrt{2}+4)^2 - 8(2\sqrt{2}+3) = 0$. [2]

(ii) Solve the equation $(2\sqrt{2}+3)x^2 - (2\sqrt{2}+4)x + 2 = 0$, giving your answer in the form $a + b\sqrt{2}$ where a and b are integers. [3]

6 Find the coordinates of the points of intersection of the curve $\dfrac{8}{x} - \dfrac{10}{y} = 1$ and the line $x + y = 9$. [6]

7 **(a)** Prove that $\dfrac{\tan\theta + \cot\theta}{\sec\theta + \operatorname{cosec}\theta} = \dfrac{1}{\sin\theta + \cos\theta}$. [3]

(b) Given that $\tan x = -\dfrac{5}{12}$ and $90° < x < 180°$, find the exact value of $\sin x$ and of $\cos x$, giving each answer as a fraction. [3]

Answer $\sin x =$ $\cos x =$

8 A curve is such that $\frac{dy}{dx} = 6x^2 - 8x + 3$.

(i) Show that the curve has no stationary points. [2]

Given that the curve passes through the point $P(2, 10)$,

(ii) find the equation of the tangent to the curve at the point P, [2]

(iii) find the equation of the curve. [4]

9 **Solutions to this question by accurate drawing will not be accepted.**
The points $A(2, 11)$, $B(-2, 3)$ and $C(2, -1)$ are the vertices of a triangle.

(i) Find the equation of the perpendicular bisector of AB. [4]

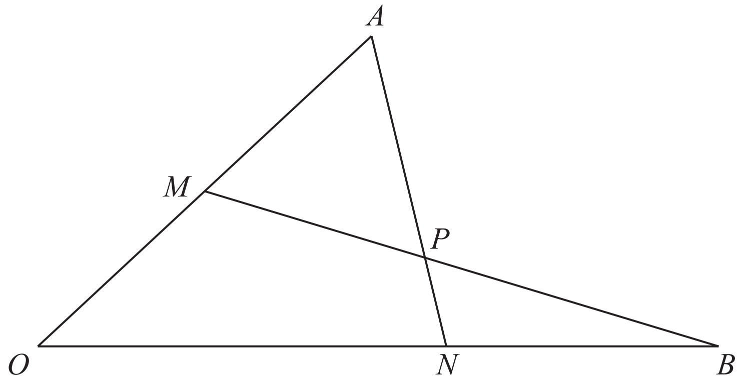
The line through A parallel to BC intersects the perpendicular bisector of AB at the point D.

(ii) Find the area of the quadrilateral $ABCD$. [6]

10 **(i)** Given that $y = \frac{2x}{\sqrt{x^2 + 21}}$, show that $\frac{dy}{dx} = \frac{k}{\sqrt{(x^2 + 21)^3}}$, where k is a constant to be found. [5]

(ii) Hence find $\int \frac{6}{\sqrt{(x^2+21)^3}}\,dx$ and evaluate $\int_2^{10} \frac{6}{\sqrt{(x^2+21)^3}}\,dx$. [3]

11



In the diagram $\overrightarrow{OA} = 2\mathbf{a}$ and $\overrightarrow{OB} = 5\mathbf{b}$. The point M is the midpoint of OA and the point N lies on OB such that $ON : NB = 3 : 2$.

(i) Find an expression for the vector $\overrightarrow{MB}$ in terms of **a** and **b**. [2]

The point P lies on AN such that $\overrightarrow{AP} = \lambda\overrightarrow{AN}$.

(ii) Find an expression for the vector $\overrightarrow{AP}$ in terms of λ, **a** and **b**. [2]

(iii) Find an expression for the vector $\overrightarrow{MP}$ in terms of λ, **a** and **b**. [2]

(iv) Given that M, P and B are collinear, find the value of λ. [4]

Question 12 is printed on the next page.

12 The function f is such that $f(x) = 2 + \sqrt{x-3}$ for $4 \leqslant x \leqslant 28$.

(i) Find the range of f. [2]

(ii) Find $f^2(12)$. [2]

(iii) Find an expression for $f^{-1}(x)$. [2]

The function g is defined by $g(x) = \dfrac{120}{x}$ for $x \geqslant 0$.

(iv) Find the value of x for which $gf(x) = 20$. [3]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0917886374

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **October/November 2013**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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The total number of marks for this paper is 80.

This document consists of **18** printed pages and **2** blank pages.

DC (LEG/SW) 67890/2

UNIVERSITY *of* CAMBRIDGE International Examinations

[Turn over

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 Find the set of values of x for which $x^2 < 6 - 5x$. [3]

For Examiner's Use

2 Do not use a calculator in this question.

Express $\dfrac{(4\sqrt{5}-2)^2}{\sqrt{5}-1}$ in the form $p\sqrt{5}+q$, where p and q are integers. [4]

For Examiner's Use

3 **(i)** Given that $y = \left(\frac{1}{4}x - 5\right)^8$, find $\frac{dy}{dx}$. [2]

(ii) Hence find the approximate change in y as x increases from 12 to $12 + p$, where p is small. [2]

4 Given that $\log_p X = 5$ and $\log_p Y = 2$, find

(i) $\log_p X^2$, [1]

(ii) $\log_p \frac{1}{X}$, [1]

(iii) $\log_{XY} p$. [2]

5 Solve the simultaneous equations

$$\frac{4^x}{256^y} = 1024,$$
$$3^{2x} \times 9^y = 243.$$

[5]

For Examiner's Use

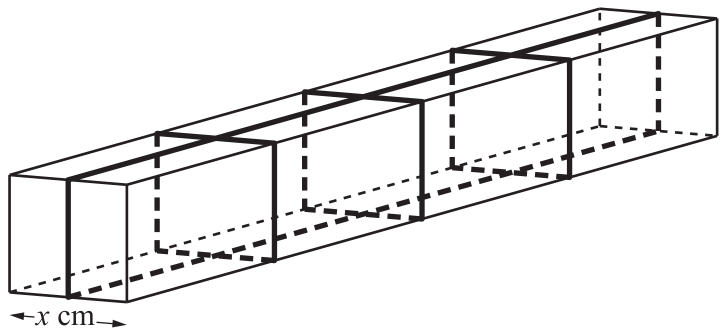
For Examiner's Use

6 **(a)** **(i)** Find the coefficient of x^3 in the expansion of $(1 - 2x)^6$. [2]

(ii) Find the coefficient of x^3 in the expansion of $\left(1 + \frac{x}{2}\right)(1 - 2x)^6$. [3]

(b) Expand $\left(2\sqrt{x} + \frac{1}{\sqrt{x}}\right)^4$ in a series of powers of x with integer coefficients. [3]

7



The diagram shows a box in the shape of a cuboid with a square cross-section of side x cm. The volume of the box is $3500\,\text{cm}^3$. Four pieces of tape are fastened round the box as shown. The pieces of tape are parallel to the edges of the box.

(i) Given that the total length of the four pieces of tape is L cm, show that $L = 14x + \dfrac{7000}{x^2}$. [3]

(ii) Given that x can vary, find the stationary value of L and determine the nature of this stationary value. [5]

8 The table shows experimental values of two variables x and y.

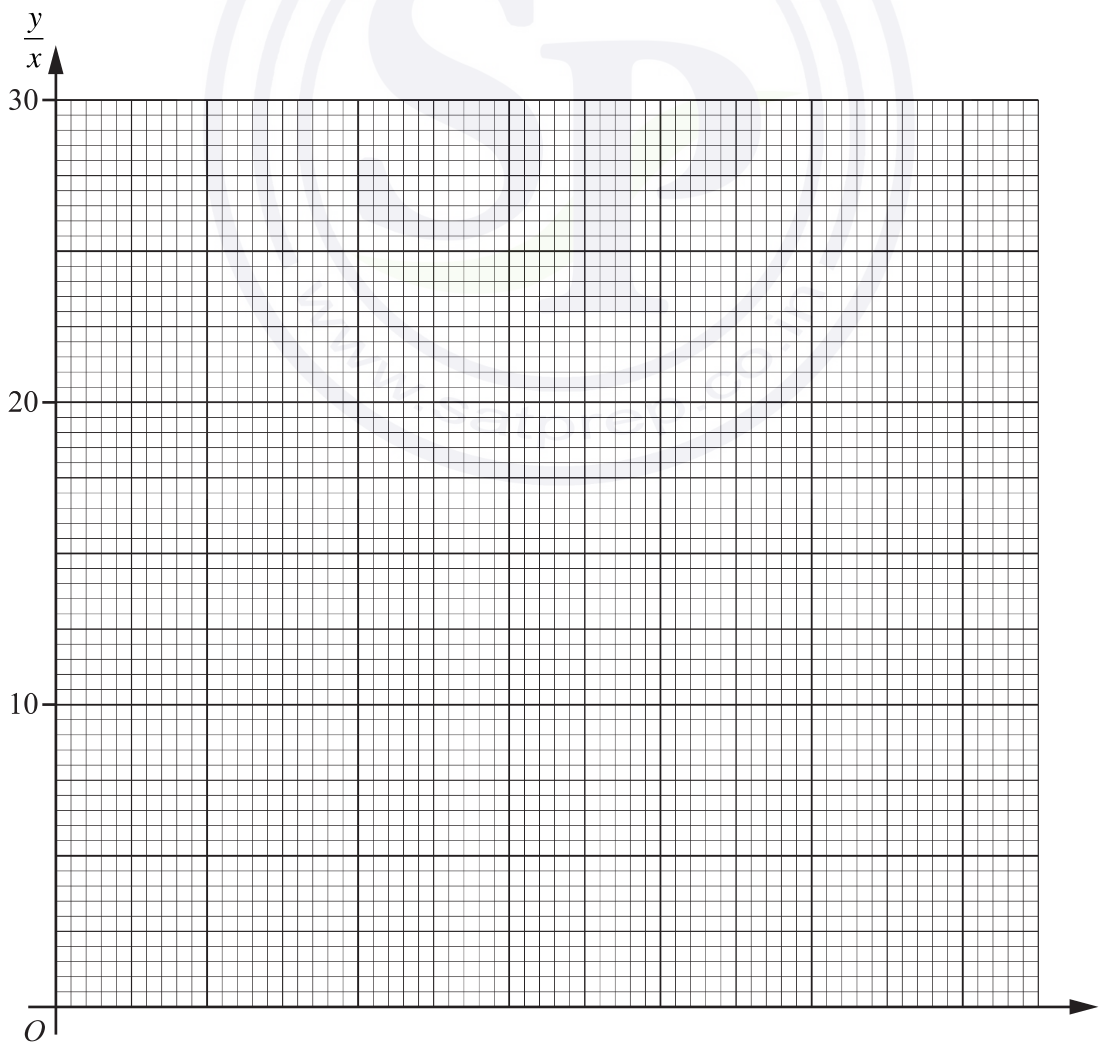
For Examiner's Use

x	2	4	6	8
y	9.6	38.4	105	232

It is known that x and y are related by the equation $y = ax^3 + bx$, where a and b are constants.

(i) A straight line graph is to be drawn for this information with $\frac{y}{x}$ on the vertical axis. State the variable which must be plotted on the horizontal axis. [1]

(ii) Draw this straight line graph on the grid below. [2]

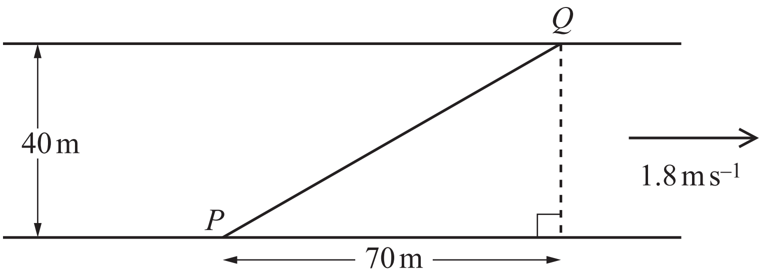


(iii) Use your graph to estimate the value of a and of b. [3]

For Examiner's Use

(iv) Estimate the value of x for which $2y = 25x$. [2]

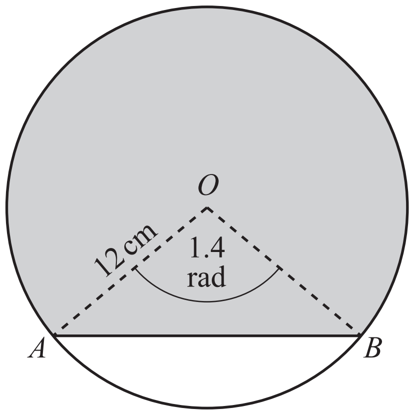
9



The diagram shows a river with parallel banks. The river is 40 m wide and is flowing with a speed of 1.8 ms^{-1}. A canoe travels in a straight line from a point P on one bank to a point Q on the opposite bank 70 m downstream from P. Given that the canoe takes 12 s to travel from P to Q, calculate the speed of the canoe in still water and the angle to the bank that the canoe was steered. [8]

For Examiner's Use

10



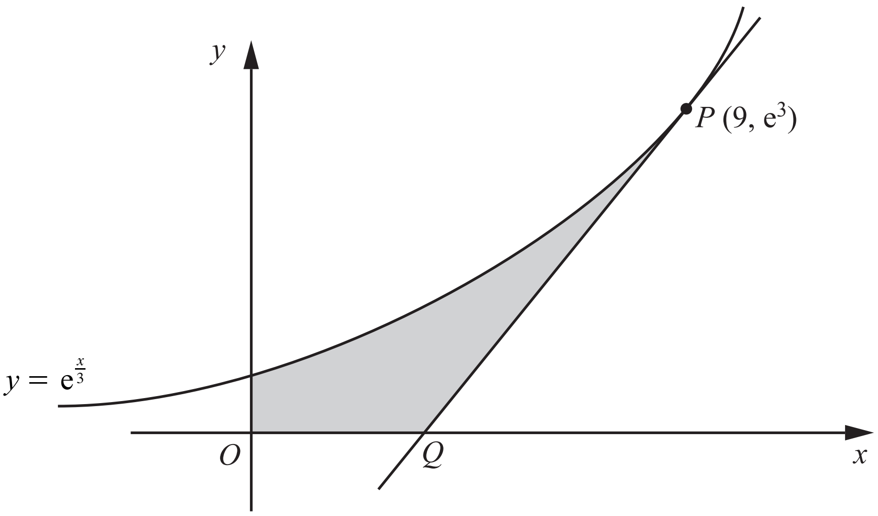
The diagram shows a circle with centre O and a chord AB. The radius of the circle is 12 cm and angle AOB is 1.4 radians.

(i) Find the perimeter of the shaded region. [5]

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

For Examiner's Use

11



The diagram shows part of the curve $y = e^{\frac{x}{3}}$. The tangent to the curve at $P\left(9, e^3\right)$ meets the x-axis at Q.

(i) Find the coordinates of Q. [4]

(ii) Find the area of the shaded region bounded by the curve, the coordinate axes and the tangent to the curve at *P*. [6]

For Examiner's Use

12 **(a)** Solve the equation $2\operatorname{cosec} x + \dfrac{7}{\cos x} = 0$ for $0° \leqslant x \leqslant 360°$. [4]

For Examiner's Use

(b) Solve the equation $7\sin(2y - 1) = 5$ for $0 \leqslant y \leqslant 5$ radians. [5]

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3031944723

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **October/November 2013**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

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DC (SJW/SW) 81064

UNIVERSITY *of* CAMBRIDGE
International Examinations

[Turn over

Mathematical Formulae

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For Examiner's Use

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For Examiner's Use

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For Examiner's Use

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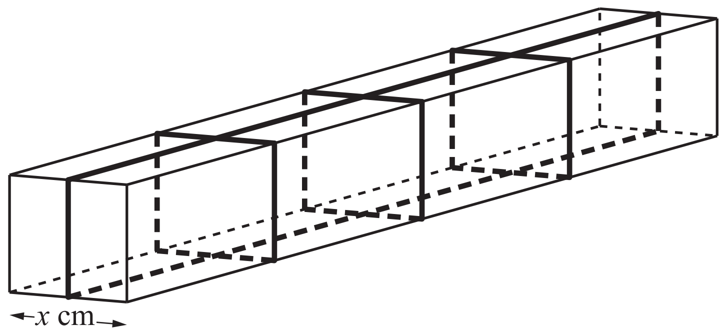

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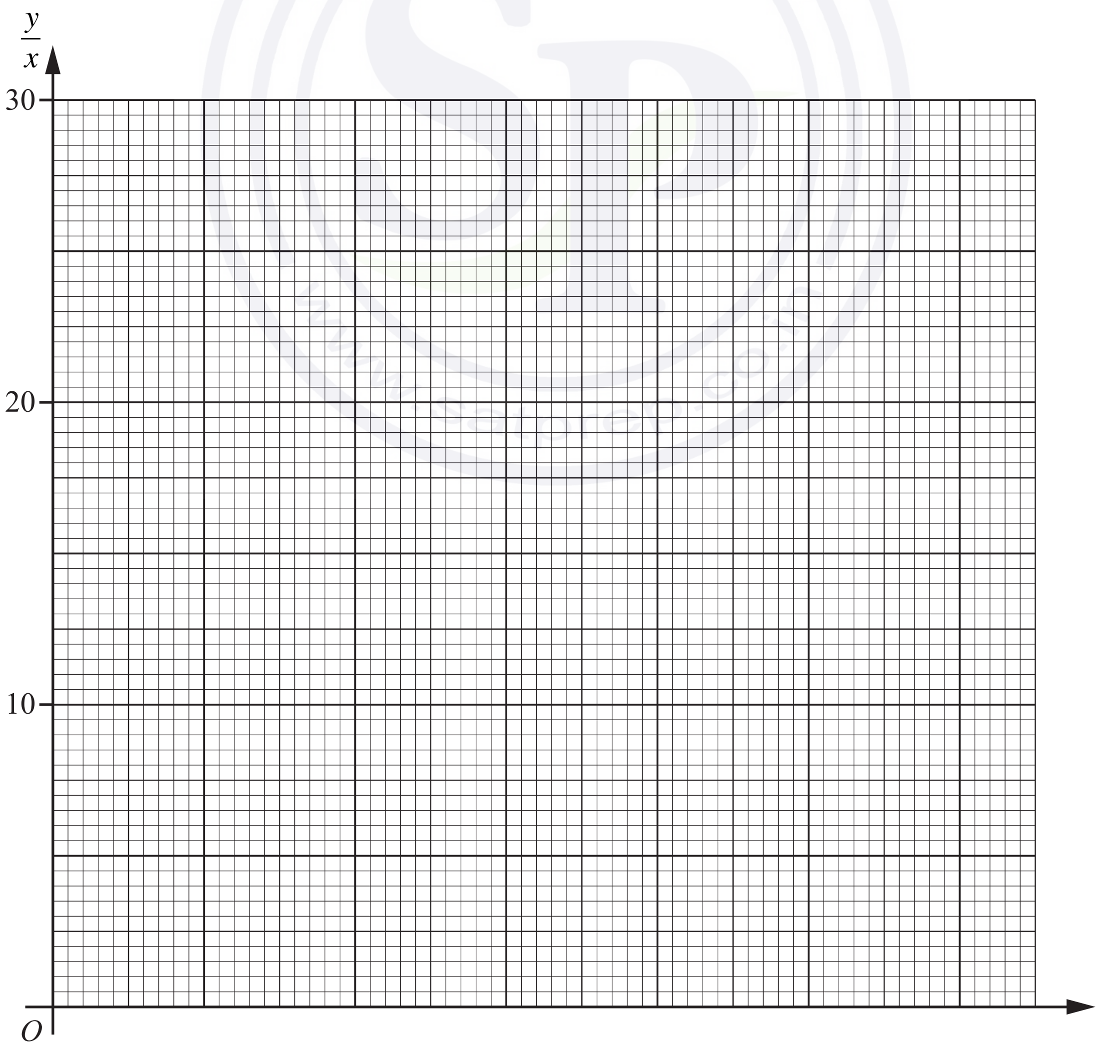

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For Examiner's Use

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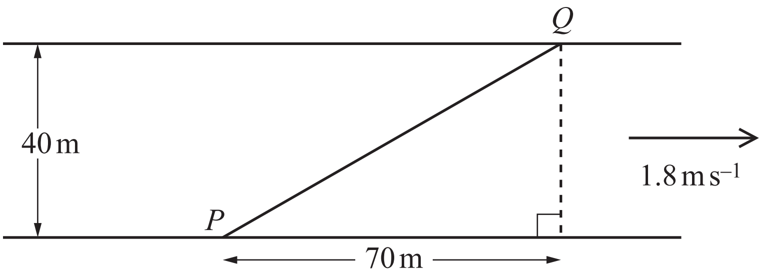
  [Turn over

9



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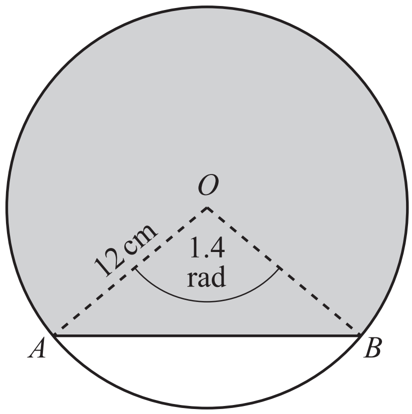
For Examiner's Use

10



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For Examiner's Use

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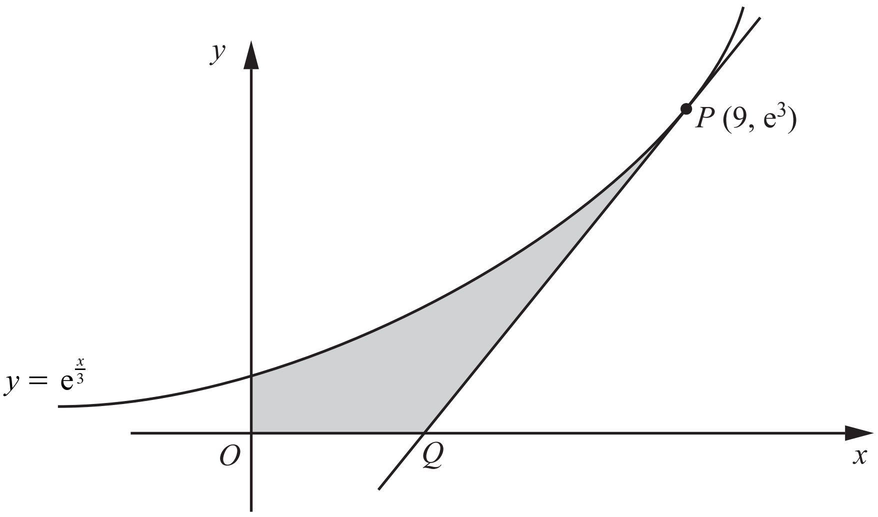
For Examiner's Use

11



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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

7132398222

ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **October/November 2013**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

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DC (KN/SW) 67884/4

UNIVERSITY *of* CAMBRIDGE International Examinations

[Turn over

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

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

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

1 Find the coordinates of the stationary points on the curve $y = x^3 - 6x^2 - 36x + 16$. [5]

For Examiner's Use

For Examiner's Use

2 **(i)** Find how many different numbers can be formed using 4 of the digits 1, 2, 3, 4, 5, 6 and 7 if no digit is repeated. [1]

Find how many of these 4-digit numbers are

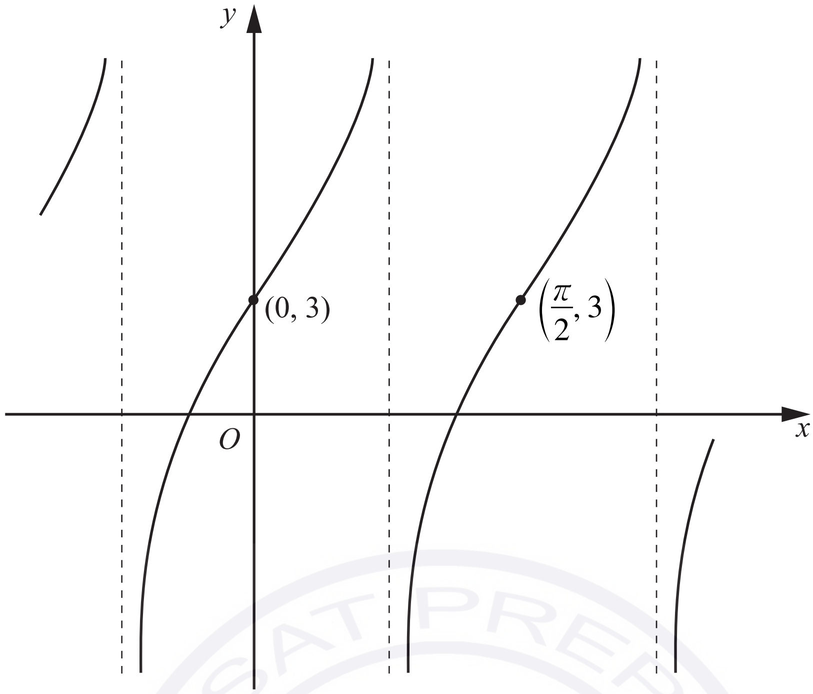
(ii) odd, [1]

(iii) odd and less than 3000. [3]

3 Find the set of values of k for which the line $y = 3x - k$ does not meet the curve $y = kx^2 + 11x - 6$. [6]

For Examiner's Use

4



(a) **(i)** The diagram shows the graph of $y = A + C\tan(Bx)$ passing through the points $(0, 3)$ and $\left(\frac{\pi}{2}, 3\right)$. Find the value of A and of B. [2]

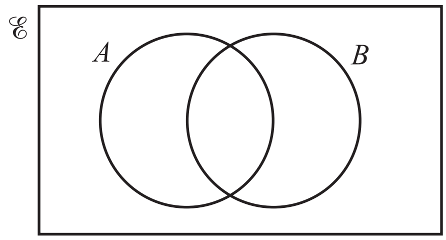
(ii) Given that the point $\left(\frac{\pi}{8}, 7\right)$ also lies on the graph, find the value of C. [1]

(b) Given that $f(x) = 8 - 5\cos 3x$, state the period and the amplitude of f. [2]

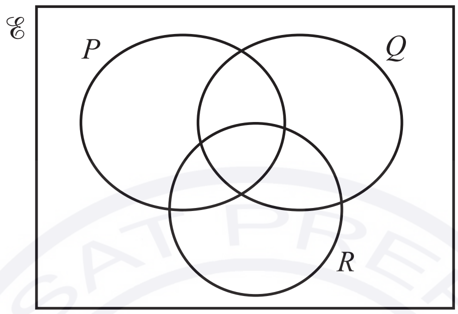
For Examiner's Use

period .... amplitude ....

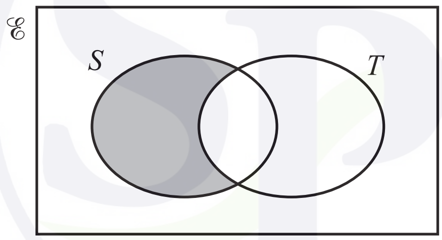
5 **(a)** **(i)** In the Venn diagram below shade the region that represents $(A \cup B)'$. [1]



(ii) In the Venn diagram below shade the region that represents $P \cap Q \cap R'$. [1]



(b) Express, in set notation, the set represented by the shaded region. [1]

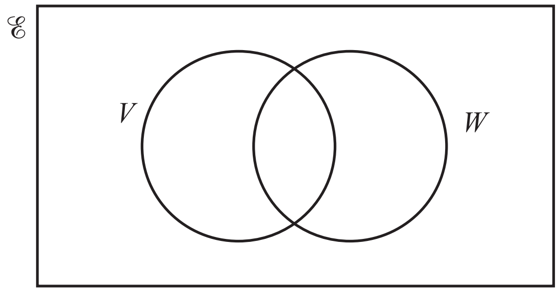


Answer ....

(c) The universal set $\mathscr{E}$ and the sets V and W are such that $n(\mathscr{E}) = 40$, $n(V) = 18$ and $n(W) = 14$. Given that $n(V \cap W) = x$ and $n((V \cup W)') = 3x$ find the value of x.

For Examiner's Use

You may use the Venn diagram below to help you. [3]



6 The expression $2x^3 + ax^2 + bx + 21$ has a factor $x + 3$ and leaves a remainder of 65 when divided by $x - 2$.

For Examiner's Use

(i) Find the value of a and of b. [5]

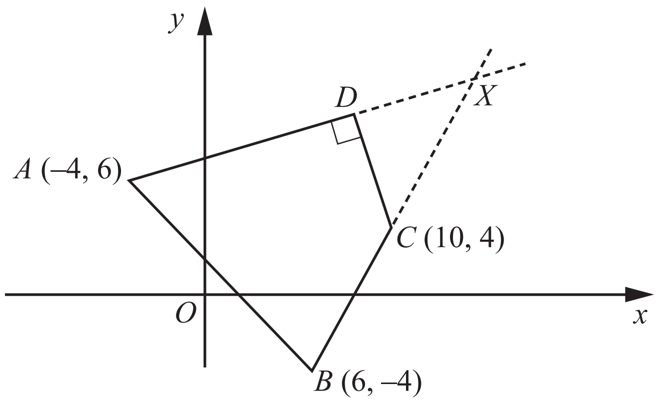
(ii) Hence find the value of the remainder when the expression is divided by $2x + 1$. [2]

7 The line $4x + y = 16$ intersects the curve $\frac{4}{x} - \frac{8}{y} = 1$ at the points A and B. The x-coordinate of A is less than the x-coordinate of B. Given that the point C lies on the line AB such that $AC : CB = 1 : 2$, find the coordinates of C. [8]

For Examiner's Use

8 Solutions to this question by accurate drawing will not be accepted.

For Examiner's Use



The diagram shows a quadrilateral $ABCD$, with vertices $A(-4, 6)$, $B(6, -4)$, $C(10, 4)$ and D. The angle $ADC = 90°$. The lines BC and AD are extended to intersect at the point X.

(i) Given that C is the midpoint of BX, find the coordinates of D. [7]

(ii) Hence calculate the area of the quadrilateral *ABCD*. [2]

For Examiner's Use

9 A particle travels in a straight line so that, t s after passing through a fixed point O, its velocity, $v\,\text{ms}^{-1}$, is given by $v = 3 + 6\sin 2t$.

For Examiner's Use

(i) Find the velocity of the particle when $t = \dfrac{\pi}{4}$. [1]

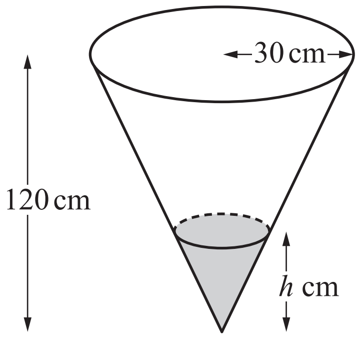
(ii) Find the acceleration of the particle when $t = 2$. [3]

The particle first comes to instantaneous rest at the point P.

(iii) Find the distance OP. [5]

For Examiner's Use

10



The volume of a cone of height H and radius R is

$$\frac{1}{3}\pi R^2 H$$

The diagram shows a container in the shape of a cone of height 120 cm and radius 30 cm. Water is poured into the container at a rate of $20\pi\,\text{cm}^3\text{s}^{-1}$.

(i) At the instant when the depth of water in the cone is h cm the volume of water in the cone is $V\,\text{cm}^3$. Show that $V = \dfrac{\pi h^3}{48}$. [3]

(ii) Find the rate at which h is increasing when $h = 50$. [3]

For Examiner's Use

(iii) Find the rate at which the circular area of the water's surface is increasing when $h = 50$. [4]

11 In this question **i** is a unit vector due east and **j** is a unit vector due north.

At time $t = 0$ boat A leaves the origin O and travels with velocity $(2\mathbf{i} + 4\mathbf{j})\,\text{km}\,\text{h}^{-1}$. Also at time $t = 0$ boat B leaves the point with position vector $(-21\mathbf{i} + 22\mathbf{j})\,\text{km}$ and travels with velocity $(5\mathbf{i} + 3\mathbf{j})\,\text{km}\,\text{h}^{-1}$.

(i) Write down the position vectors of boats A and B after t hours. [2]

(ii) Show that A and B are 25 km apart when $t = 2$. [3]

(iii) Find the length of time for which A and B are less than 25 km apart. [5]

For Examiner's Use

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

5272705046

ADDITIONAL MATHEMATICS **0606/21**

Paper 2 **May/June 2013**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator

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DC (NH/SW) 57089/6

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Mathematical Formulae

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For Examiner's Use

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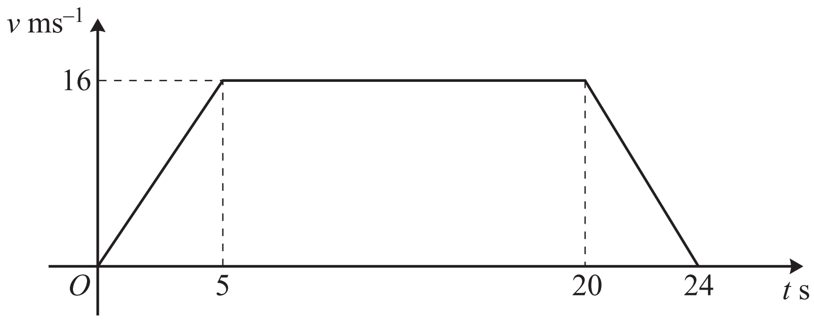

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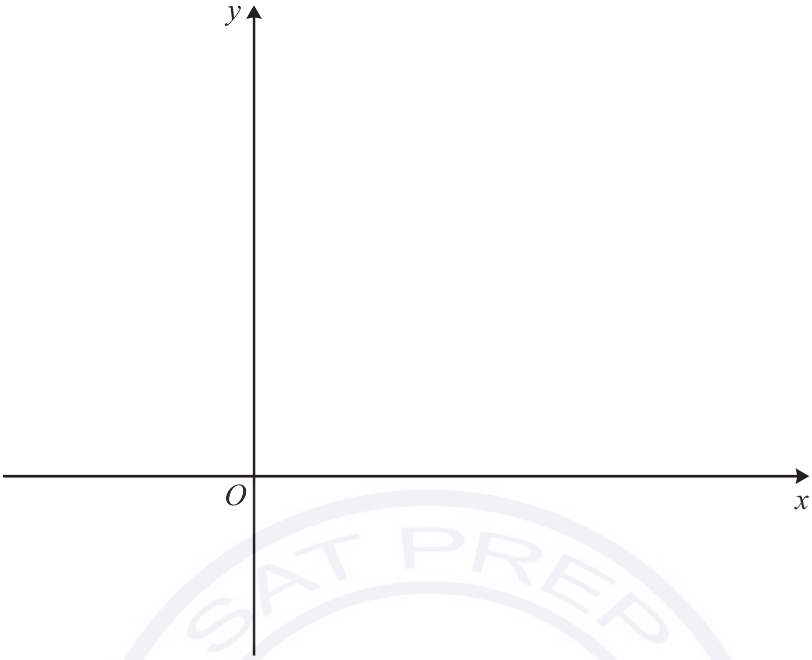

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For Examiner's Use

For Examiner's Use

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For Examiner's Use

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For Examiner's Use

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For Examiner's Use

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For Examiner's Use

(i) State the least value that k can take. [1]

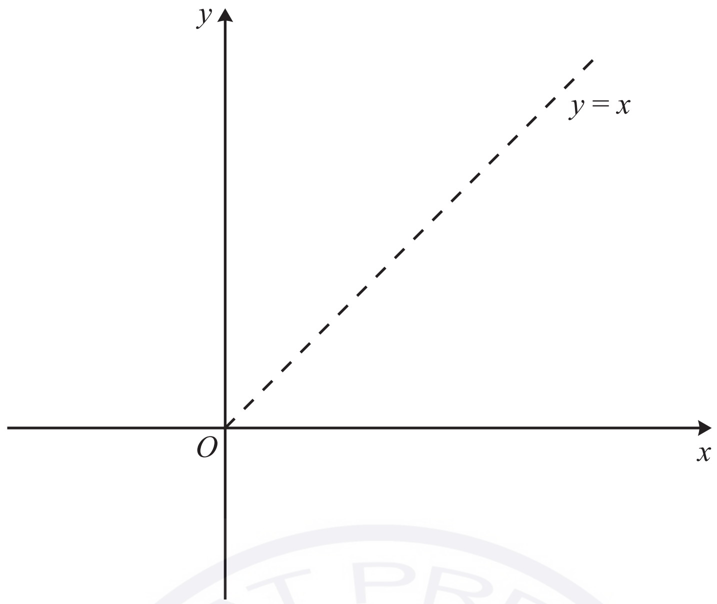
For this least value of k

(ii) write down the range of f, [1]

(iii) find $f^{-1}(x)$, [2]

(iv) sketch and label, on the axes below, the graph of $y = f(x)$ and of $y = f^{-1}(x)$, [2]

For Examiner's Use



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12 The function $f(x) = x^3 + x^2 + ax + b$ is divisible by $x - 3$ and leaves a remainder of 20 when divided by $x + 1$.

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

5899832647

ADDITIONAL MATHEMATICS **0606/22**

Paper 2 **May/June 2013**

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 a pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, 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 **15** printed pages and **1** blank page.

DC (NH/SW) 57090/3

UNIVERSITY of CAMBRIDGE International Examinations

[Turn over

Mathematical Formulae

1. ALGEBRA

Quadratic Equation

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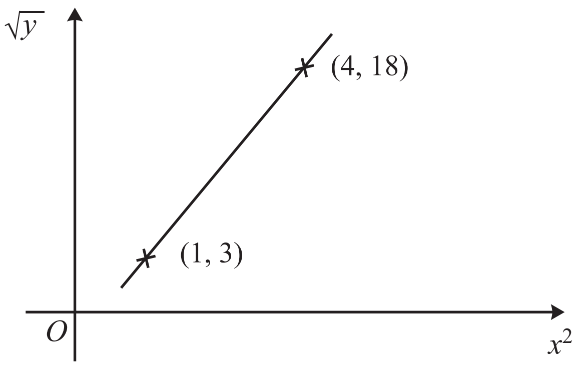
1

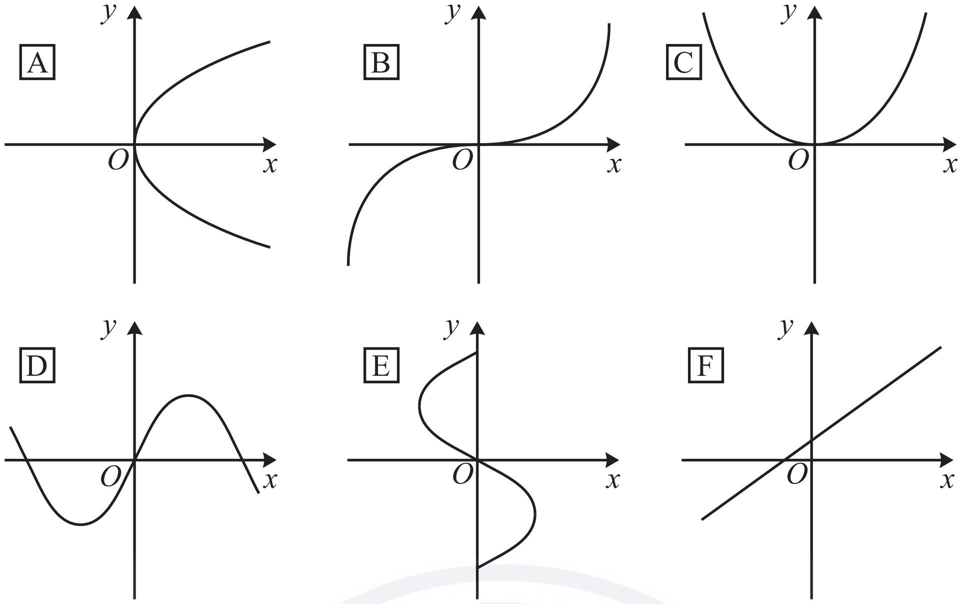


Variables x and y are such that when $\sqrt{y}$ is plotted against x^2 a straight line graph passing through the points (1, 3) and (4, 18) is obtained. Express y in terms of x. [4]

2 **(a)** Solve the equation $3^{p+1} = 0.7$, giving your answer to 2 decimal places. [3]

(b) Express $\dfrac{y \times (4x^3)^2}{\sqrt{8y^3}}$ in the form $2^a \times x^b \times y^c$, where a, b and c are constants. [3]

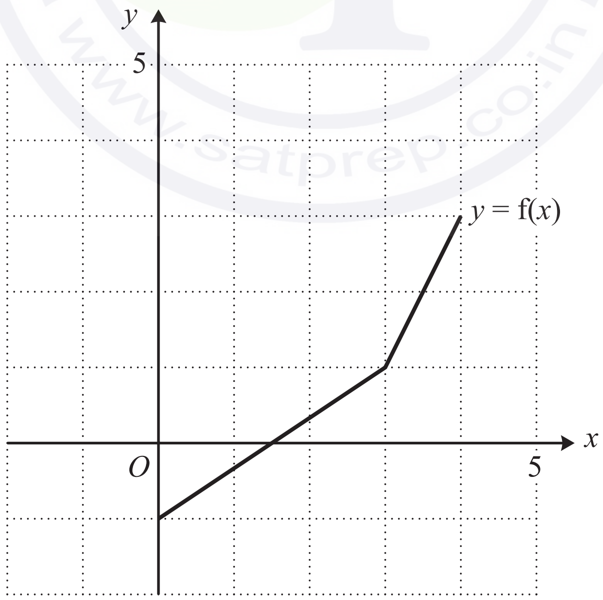
3 **(a)**



(i) Write down the letter of each graph which does **not** represent a function. [2]

(ii) Write down the letter of each graph which represents a function that does **not** have an inverse. [2]

(b)



The diagram shows the graph of a function $y = \mathrm{f}(x)$. On the same axes sketch the graph of $y = \mathrm{f}^{-1}(x)$. [2]

For Examiner's Use

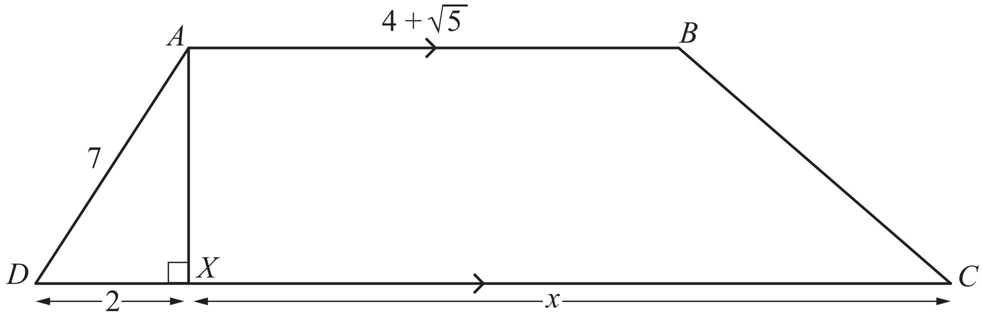
For Examiner's Use

4 The position vectors of the points A and B, relative to an origin O, are $4\mathbf{i} - 21\mathbf{j}$ and $22\mathbf{i} - 30\mathbf{j}$ respectively. The point C lies on AB such that $\overrightarrow{AB} = 3\overrightarrow{AC}$.

(i) Find the position vector of C relative to O. [4]

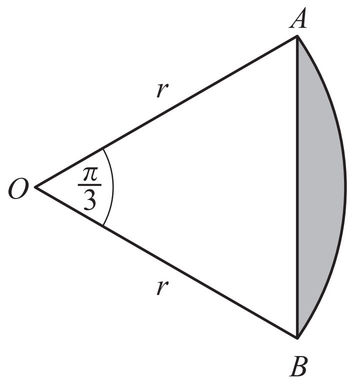
(ii) Find the unit vector in the direction $\overrightarrow{OC}$. [2]

5 Calculators must not be used in this question.



The diagram shows a trapezium $ABCD$ in which $AD = 7$ cm and $AB = (4 + \sqrt{5})$cm. AX is perpendicular to DC with $DX = 2$ cm and $XC = x$ cm. Given that the area of trapezium $ABCD$ is $15(\sqrt{5} + 2)\text{cm}^2$, obtain an expression for x in the form $a + b\sqrt{5}$, where a and b are integers. [6]

6



The shaded region in the diagram is a segment of a circle with centre O and radius r cm.

Angle $AOB = \frac{\pi}{3}$ radians.

(i) Show that the perimeter of the segment is $r\left(\frac{3+\pi}{3}\right)$ cm. [2]

(ii) Given that the perimeter of the segment is 26 cm, find the value of r and the area of the segment. [5]

For Examiner's Use

7 Differentiate, with respect to x,

For Examiner's Use

(i) $(3-5x)^{12}$, [2]

(ii) $x^2 \sin x$, [2]

(iii) $\dfrac{\tan x}{1+e^{2x}}$. [4]

8 Solutions to this question by accurate drawing will not be accepted.

For Examiner's Use

The points $A(-6, 2)$, $B(2, 6)$ and C are the vertices of a triangle.

(i) Find the equation of the line AB in the form $y = mx + c$. [2]

(ii) Given that angle $ABC = 90°$, find the equation of BC. [2]

(iii) Given that the length of AC is 10 units, find the coordinates of each of the two possible positions of point C. [4]

9 **(a)** The graph of $y = k(3^x) + c$ passes through the points (0, 14) and (−2, 6). Find the value of k and of c. [3]

For Examiner's Use

(b) The variables x and y are connected by the equation $y = e^x + 25 - 24e^{-x}$.

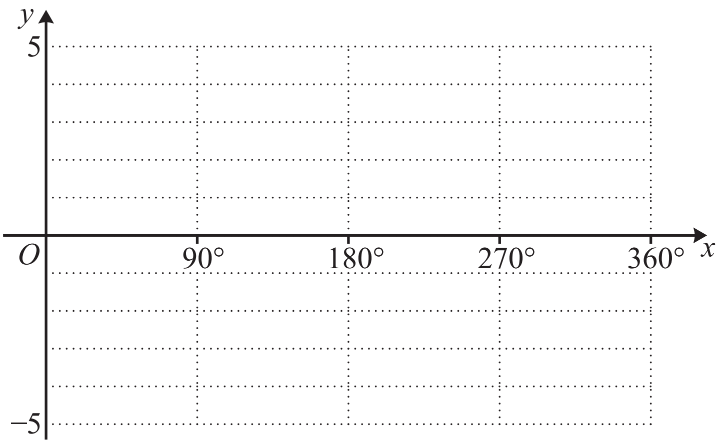
(i) Find the value of y when $x = 4$. [1]

(ii) Find the value of e^x when $y = 20$ and hence find the corresponding value of x. [4]

10 **(a)** The function f is defined, for $0° \leqslant x \leqslant 360°$, by $f(x) = 1 + 3\cos 2x$.

For Examiner's Use

(i) Sketch the graph of $y = f(x)$ on the axes below. [4]



(ii) State the amplitude of f. [1]

(iii) State the period of f. [1]

(b) Given that $\cos x = p$, where $270° < x < 360°$, find $\operatorname{cosec} x$ in terms of p. [3]

For Examiner's Use

11 A curve has equation $y = 3x + \frac{1}{(x-4)^3}$.

(i) Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$. [4]

(ii) Show that the coordinates of the stationary points of the curve are (5, 16) and (3, 8). [2]

(iii) Determine the nature of each of these stationary points. [2]

(iv) Find $\int \left(3x + \frac{1}{(x-4)^3}\right) \mathrm{d}x$. [2]

For Examiner's Use

(v) Hence find the area of the region enclosed by the curve, the line $x = 5$, the x-axis and the line $x = 6$. [2]

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

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Paper 2 **May/June 2013**

2 hours

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DC (JF/SW) 71796

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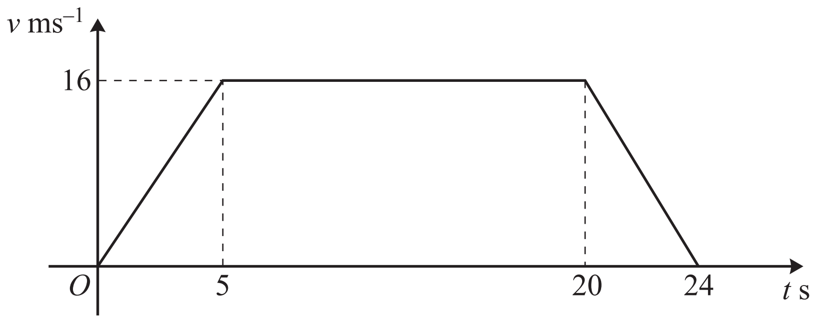

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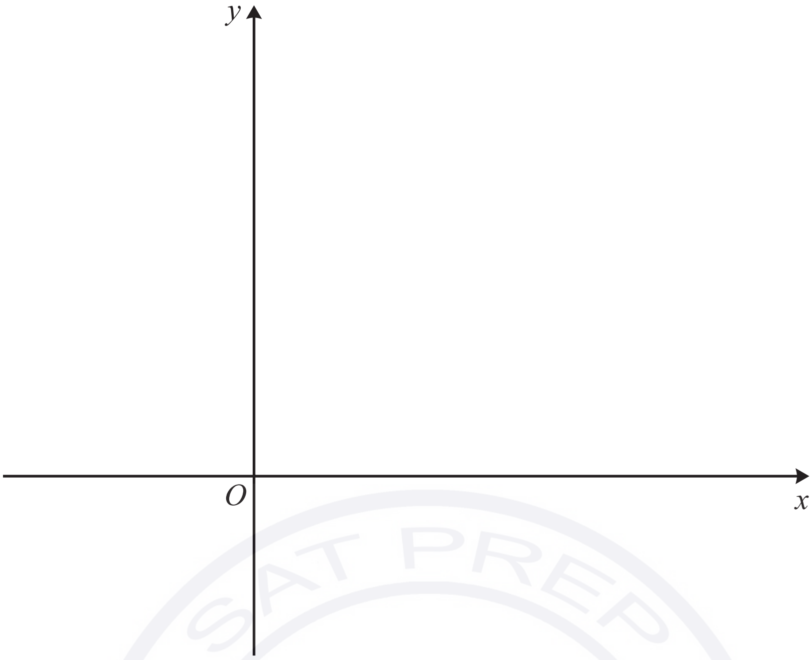

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For Examiner's Use

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For Examiner's Use

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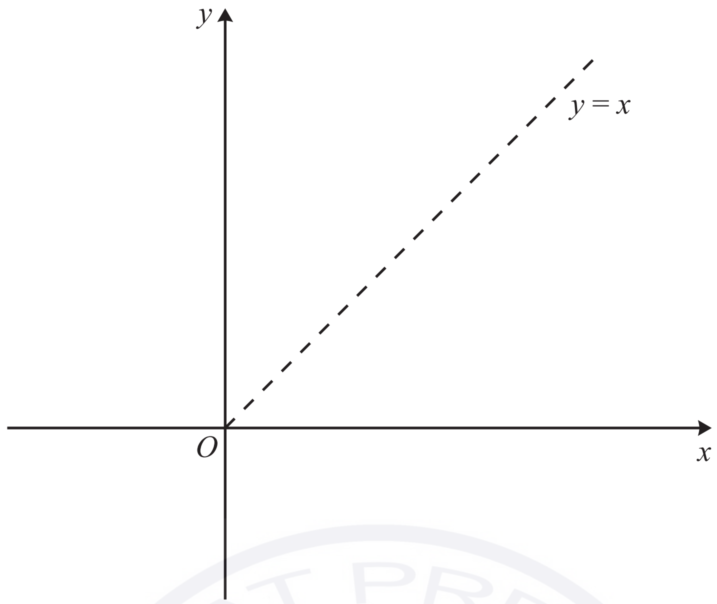
For Examiner's Use



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