



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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4037/22

May/June 2022

2 hours

You must answer on the question paper.

No additional materials are needed.

- 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.

- 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.

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

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

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*

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

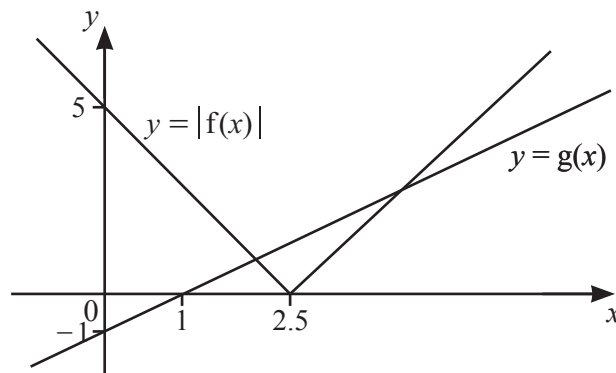
Formulae for $\triangle ABC$

$$\begin{aligned}\frac{a}{\sin A} &= \frac{b}{\sin B} = \frac{c}{\sin C} \\ a^2 &= b^2 + c^2 - 2bc \cos A \\ \Delta &= \frac{1}{2}bc \sin A\end{aligned}$$

1 DO NOT USE A CALCULATOR IN THIS QUESTION.

A curve has equation $y = \frac{6 + \sqrt{x}}{3 + \sqrt{x}}$ where $x \geq 0$. 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



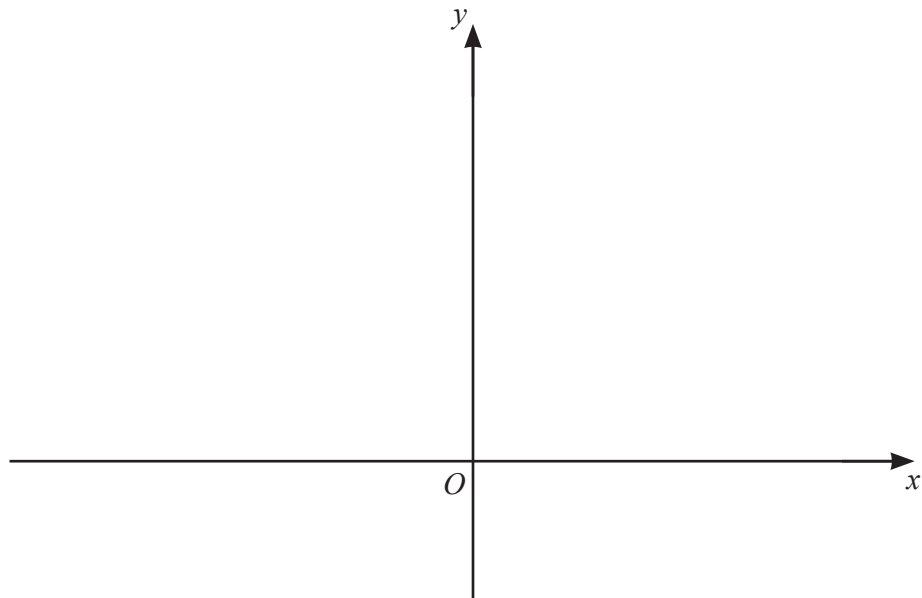
The diagram shows the graphs of $y = |f(x)|$ and $y = g(x)$, where $y = f(x)$ and $y = g(x)$ are straight lines. Solve the inequality $|f(x)| \leq g(x)$. [5]

- 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 $\frac{625^{\frac{x^3-1}{2}}}{125^{x^3}} = 5$. [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, $\mathbf{i}$ is a unit vector due east and $\mathbf{j}$ is a unit vector due north.

A cyclist rides at a speed of 4 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 $\mathbf{v}$. Find the magnitude and bearing of $\mathbf{v}$. [5]

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

[4]

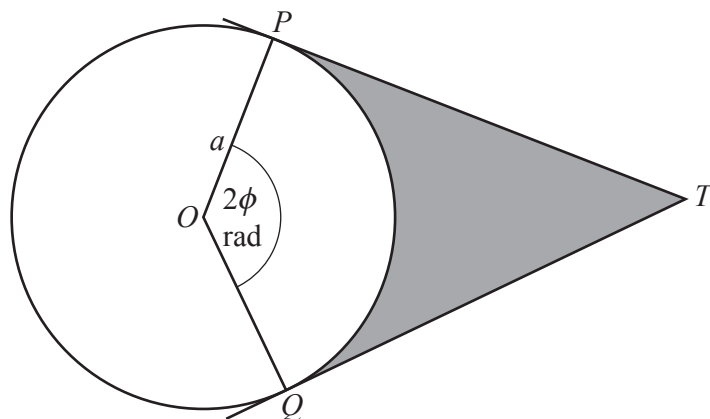
8 The function f is defined by $f(x) = 3 \sin^2 x - 2 \cos x$ for $2 \leq x \leq 4$, where x is in radians.

(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]

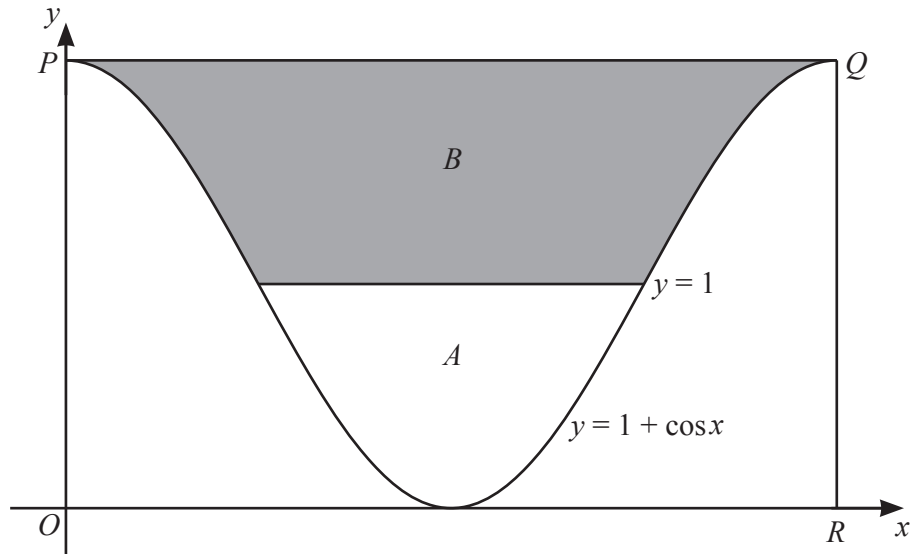
(ii) Find the value of a . [3]

- (b) An arithmetic progression has first term p and common difference 2. The q th 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 $\frac{d^2y}{dx^2} = \left(\frac{\sqrt{x}+1}{\sqrt[4]{x}}\right)^2$. Given that the gradient of the curve is $\frac{4}{3}$ at the point $(1, -1)$, find the equation of the curve. [7]

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