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ADDITIONAL MATHEMATICS

0606/12

Paper 1

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.

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*

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

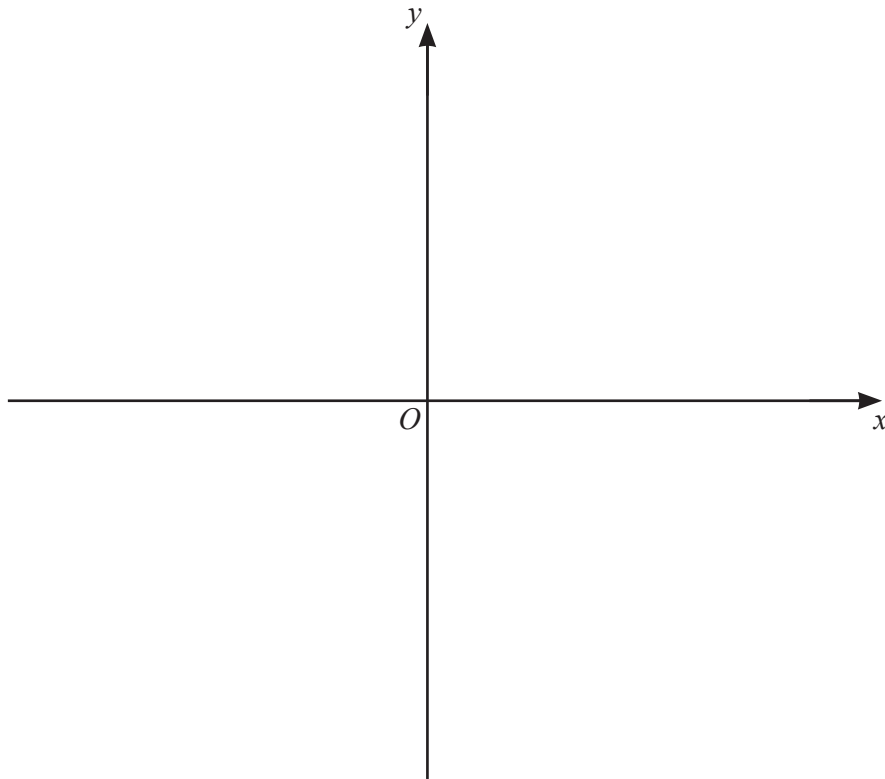
Formulae for $\triangle ABC$

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

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

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

- 1 (a) On the axes below sketch the graph of $y = -3(x-2)(x-4)(x+1)$, showing the coordinates of the points where the curve intersects the coordinate axes. [3]



- (b) Hence find the values of x for which $-3(x-2)(x-4)(x+1) > 0$. [2]

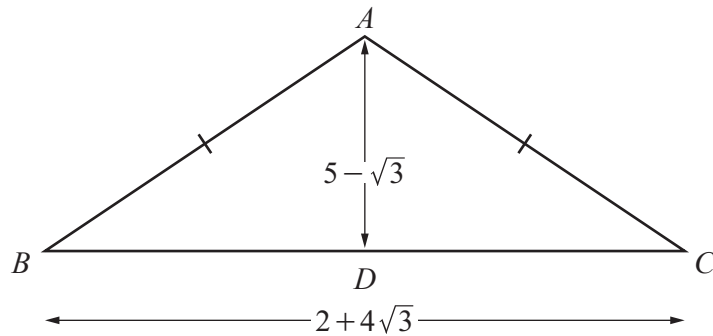
- 2 Find the values of k for which the line $y = kx + 3$ is a tangent to the curve $y = 2x^2 + 4x + k - 1$. [5]

- 3 The first 3 terms in the expansion of $(3 - ax)^5$, in ascending powers of x , can be written in the form $b - 81x + cx^2$. Find the value of each of a , b and c . [5]

- 4 The tangent to the curve $y = \ln(3x^2 - 4) - \frac{x^3}{6}$, at the point where $x = 2$, meets the y -axis at the point P . Find the exact coordinates of P . [6]

5 DO NOT USE A CALCULATOR IN THIS QUESTION.

In this question all lengths are in centimetres.



The diagram shows the isosceles triangle ABC , where $AB = AC$ and $BC = 2 + 4\sqrt{3}$. The height, AD , of the triangle is $5 - \sqrt{3}$.

- (a) Find the area of the triangle ABC , giving your answer in the form $a + b\sqrt{3}$, where a and b are integers. [2]

- (b) Find $\tan \angle ABC$, giving your answer in the form $c + d\sqrt{3}$, where c and d are integers. [3]

- (c) Find $\sec^2 \angle ABC$, giving your answer in the form $e + f\sqrt{3}$, where e and f are integers. [2]

6 Solutions by accurate drawing will not be accepted.

The points A and B have coordinates $(-2, 4)$ and $(6, 10)$ respectively.

- (a) Find the equation of the perpendicular bisector of the line AB , giving your answer in the form $ax + by + c = 0$, where a , b and c are integers. [4]

The point C has coordinates $(5, p)$ and lies on the perpendicular bisector of AB .

- (b) Find the value of p . [1]

It is given that the line AB bisects the line CD .

- (c) Find the coordinates of D . [2]

7 $p(x) = ax^3 + 3x^2 + bx - 12$ has a factor of $2x + 1$. When $p(x)$ is divided by $x - 3$ the remainder is 105.

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

(b) Using your values of a and b , write $p(x)$ as a product of $2x + 1$ and a quadratic factor. [2]

(c) Hence solve $p(x) = 0$. [2]

8 In this question all distances are in km.

A ship P sails from a point A , which has position vector $\begin{pmatrix} 0 \\ 0 \end{pmatrix}$, with a speed of 52 kmh^{-1} in the direction of $\begin{pmatrix} -5 \\ 12 \end{pmatrix}$.

(a) Find the velocity vector of the ship. [1]

(b) Write down the position vector of P at a time t hours after leaving A . [1]

At the same time that ship P sails from A , a ship Q sails from a point B , which has position vector $\begin{pmatrix} 12 \\ 8 \end{pmatrix}$, with velocity vector $\begin{pmatrix} -25 \\ 45 \end{pmatrix} \text{ kmh}^{-1}$.

(c) Write down the position vector of Q at a time t hours after leaving B . [1]

(d) Using your answers to **parts (b) and (c)**, find the displacement vector \overrightarrow{PQ} at time t hours. [1]

(e) Hence show that $PQ = \sqrt{34t^2 - 168t + 208}$. [2]

(f) Find the value of t when P and Q are first 2 km apart. [2]

- 9 (a) (i) Find how many different 4-digit numbers can be formed using the digits 2, 3, 5, 7, 8 and 9, if each digit may be used only once in any number. [1]
- (ii) How many of the numbers found in **part (i)** are divisible by 5? [1]
- (iii) How many of the numbers found in **part (i)** are odd and greater than 7000? [4]

- (b) The number of combinations of n items taken 3 at a time is $92n$. Find the value of the constant n .
[4]

10 (a) Solve $\tan(\alpha + 45^\circ) = -\frac{1}{\sqrt{2}}$ for $0^\circ \leq \alpha \leq 360^\circ$. [3]

(b) (i) Show that $\frac{1}{\sin \theta - 1} - \frac{1}{\sin \theta + 1} = a \sec^2 \theta$, where a is a constant to be found. [3]

(ii) Hence solve $\frac{1}{\sin 3\phi - 1} - \frac{1}{\sin 3\phi + 1} = -8$ for $-\frac{\pi}{3} \leq \phi \leq \frac{\pi}{3}$ radians. [5]

Question 11 is on the next page.

11 Given that $\int_1^a \left(\frac{2}{2x+3} + \frac{3}{3x-1} - \frac{1}{x} \right) dx = \ln 2.4$ and that $a > 1$, find the value of a . [7]

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