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## 4037/22

October/November 2021

**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. Any 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*

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

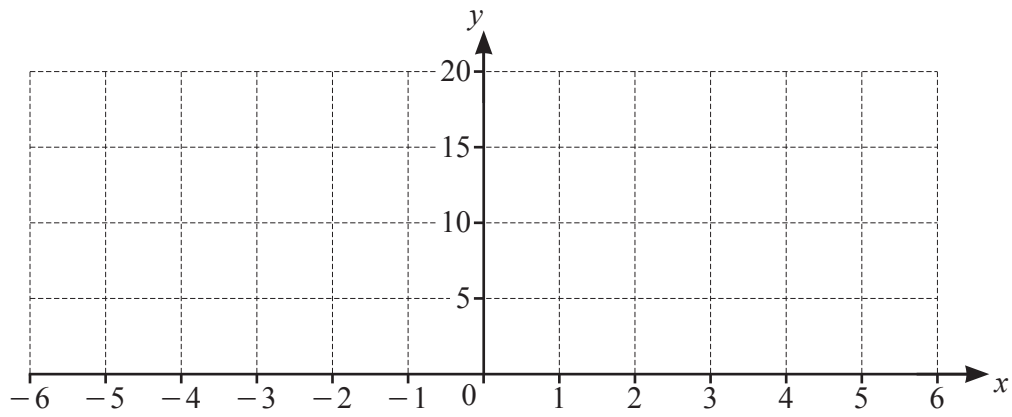
*Formulae for  $\triangle ABC$* 

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

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

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

1



- (a) On the axes, 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  $0^\circ < x < 360^\circ$ . [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.

$$\begin{aligned}e^x + e^y &= 5 \\ 2e^x - 3e^y &= 8\end{aligned}$$

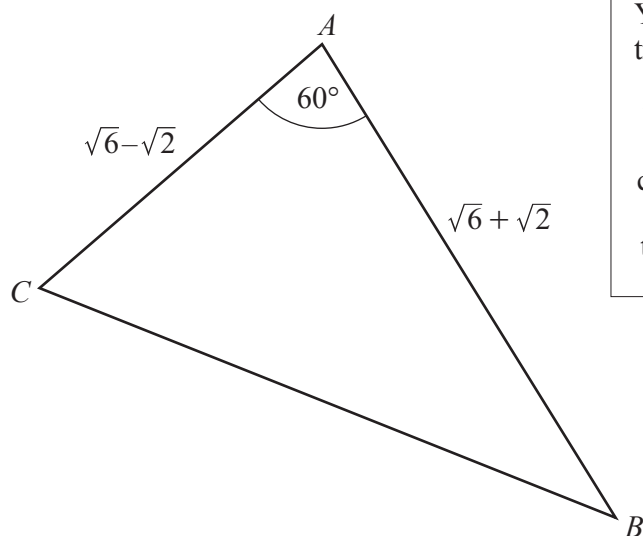
[5]

- (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.

$$\sin 60^\circ = \frac{\sqrt{3}}{2}$$

$$\cos 60^\circ = \frac{1}{2}$$

$$\tan 60^\circ = \sqrt{3}$$

The diagram shows triangle  $ABC$  with  $AC = \sqrt{6} - \sqrt{2}$ ,  $AB = \sqrt{6} + \sqrt{2}$  and angle  $CAB = 60^\circ$ .

(a) Find the exact length of  $BC$ .

[3]

(b) Show that  $\sin ACB = \frac{\sqrt{6} + \sqrt{2}}{4}$ .

[2]

(c) Show that the perpendicular distance from  $A$  to the line  $BC$  is 1.

[2]

7 It is given that  $\frac{d^2y}{dx^2} = e^{2x} + \frac{1}{(x+1)^2}$  for  $x > -1$ .

(a) Find an expression for  $\frac{dy}{dx}$  given that  $\frac{dy}{dx} = 2$  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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