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## 4037/11

May/June 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*

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

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

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

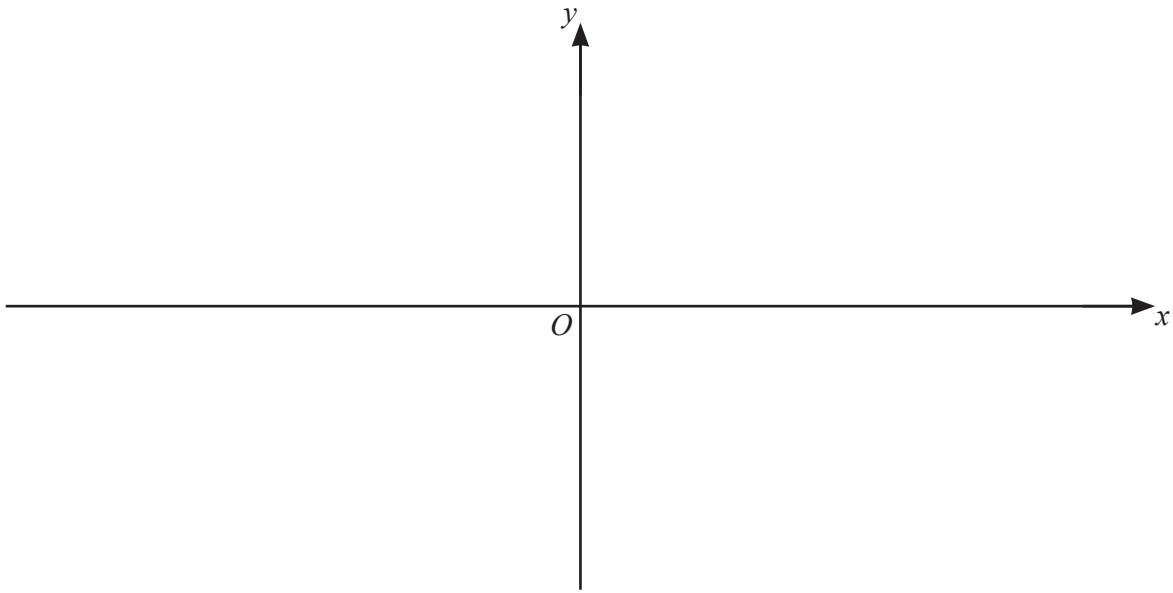
**2. TRIGONOMETRY***Identities*

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

*Formulae for  $\triangle ABC$* 

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

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



- (b) Hence find the values of  $x$  for which  $5(x+1)(3x-2)(x-2) > 0$ . [2]

- 2 Find  $\int_3^5 \left( \frac{1}{x-1} - \frac{1}{(x-1)^2} \right) dx$ , giving your answer in the form  $a + \ln b$ , where  $a$  and  $b$  are rational numbers. [5]

- 3** The polynomial  $p(x) = ax^3 - 9x^2 + bx - 6$ , where  $a$  and  $b$  are constants, has a factor of  $x - 2$ . The polynomial has a remainder of 66 when divided by  $x - 3$ .

**(a)** Find the value of  $a$  and of  $b$ . [4]

**(b)** Using your values of  $a$  and  $b$ , show that  $p(x) = (x - 2)q(x)$ , where  $q(x)$  is a quadratic factor to be found. [2]

**(c)** Hence show that the equation  $p(x) = 0$  has only one real solution. [2]

- 4 The first 3 terms in the expansion of  $(a+x)^3\left(1-\frac{x}{3}\right)^5$ , in ascending powers of  $x$ , can be written in the form  $27+bx+cx^2$ , where  $a$ ,  $b$  and  $c$  are integers. Find the values of  $a$ ,  $b$  and  $c$ . [8]

**5** The functions  $f$  and  $g$  are defined as follows.

$$f(x) = x^2 + 4x \quad \text{for } x \in \mathbb{R}$$

$$g(x) = 1 + e^{2x} \quad \text{for } x \in \mathbb{R}$$

**(a)** Find the range of  $f$ . [2]

**(b)** Write down the range of  $g$ . [1]

**(c)** Find the exact solution of the equation  $fg(x) = 21$ , giving your answer as a single logarithm. [4]

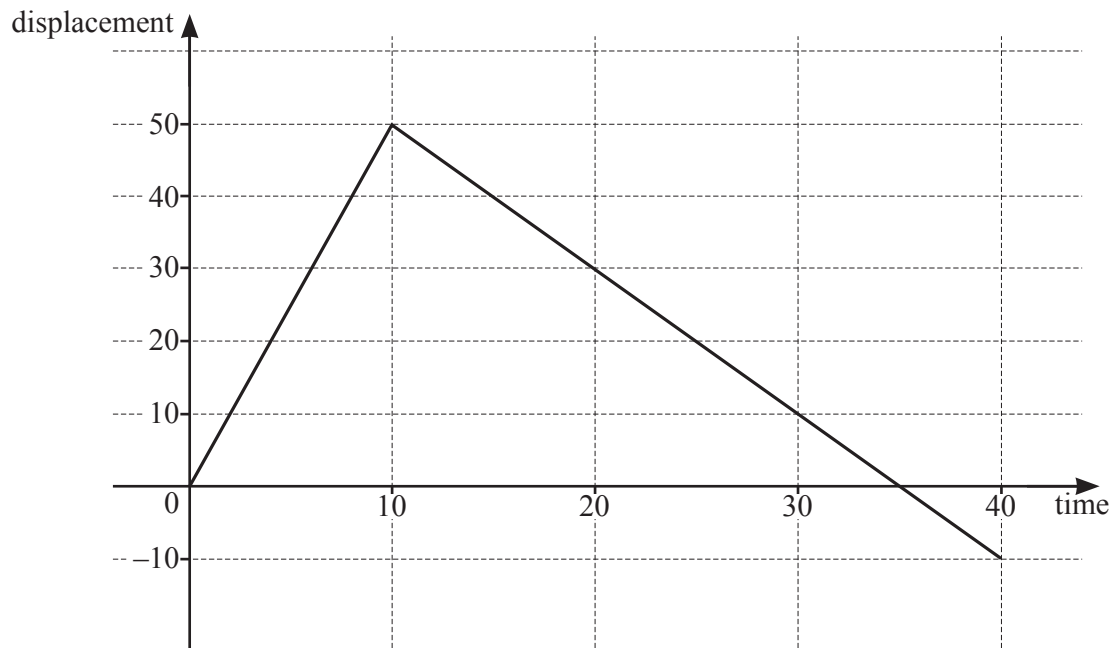
- 6 (a) (i) Find how many different 5-digit numbers can be formed using the digits 1, 3, 5, 6, 8 and 9. No digit may be used more than once in any 5-digit number. [1]

(ii) How many of these 5-digit numbers are odd? [1]

(iii) How many of these 5-digit numbers are odd and greater than 60 000? [3]

(b) Given that  $45 \times {}^nC_4 = (n+1) \times {}^{n+1}C_5$ , find the value of  $n$ . [4]

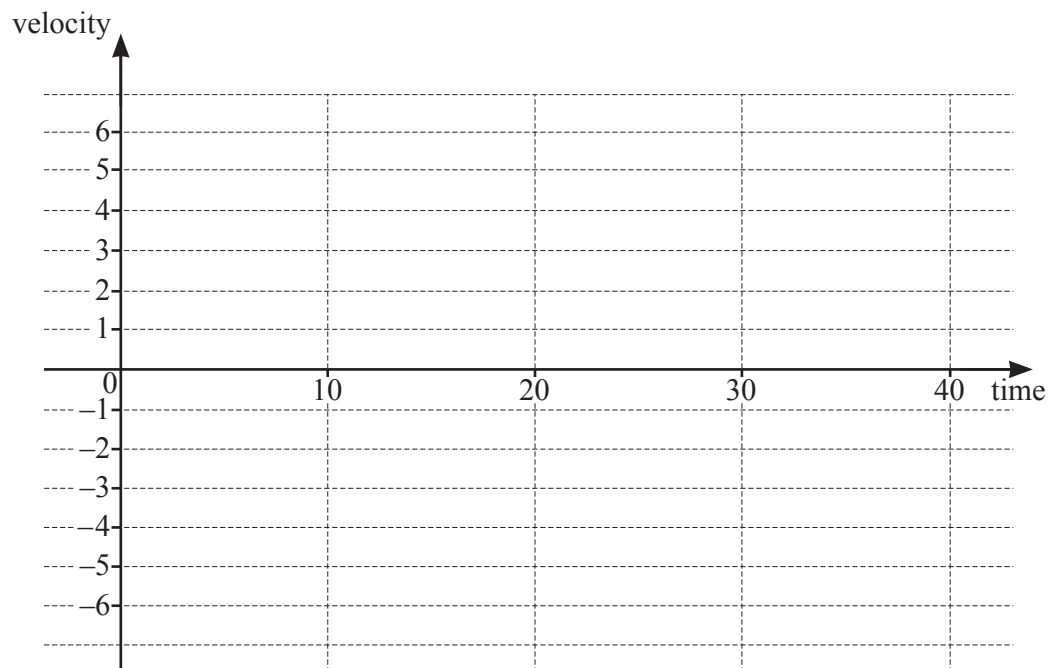
- 7 (a) In this question, all lengths are in metres and time,  $t$ , is in seconds.



The diagram shows the displacement–time graph for a runner, for  $0 \leq t \leq 40$ .

- (i) Find the distance the runner has travelled when  $t = 40$ . [1]

- (ii) On the axes, draw the corresponding velocity–time graph for the runner, for  $0 \leq t \leq 40$ . [2]





- (b) A particle,  $P$ , moves in a straight line such that its displacement from a fixed point at time  $t$  is  $s$ .

The acceleration of  $P$  is given by  $(2t+4)^{-\frac{1}{2}}$ , for  $t > 0$ .

- (i) Given that  $P$  has a velocity of 9 when  $t = 6$ , find the velocity of  $P$  at time  $t$ . [3]

- (ii) Given that  $s = \frac{1}{3}$  when  $t = 6$ , find the displacement of  $P$  at time  $t$ . [3]

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

A curve has equation  $y = (2 - \sqrt{3})x^2 + x - 1$ . The  $x$ -coordinate of a point  $A$  on the curve is  $\frac{\sqrt{3} + 1}{2 - \sqrt{3}}$ .

- (a) Show that the coordinates of  $A$  can be written in the form  $(p + q\sqrt{3}, r + s\sqrt{3})$ , where  $p$ ,  $q$ ,  $r$  and  $s$  are integers. [5]

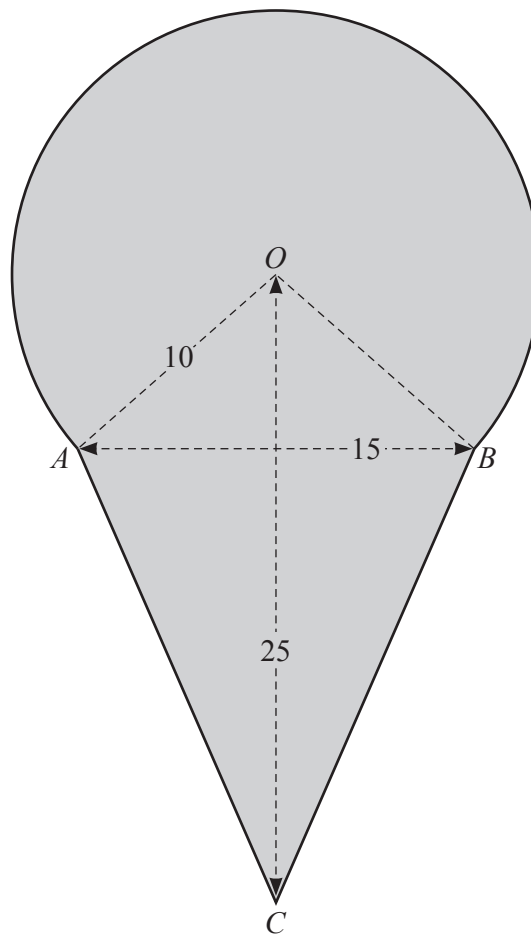
- (b) Find the  $x$ -coordinate of the stationary point on the curve, giving your answer in the form  $a + b\sqrt{3}$ , where  $a$  and  $b$  are rational numbers. [3]

- 9 (a) (i) Write  $6xy + 3y + 4x + 2$  in the form  $(ax + b)(cy + d)$ , where  $a$ ,  $b$ ,  $c$  and  $d$  are positive integers. [1]

- (ii) Hence solve the equation  $6 \sin \theta \cos \theta + 3 \cos \theta + 4 \sin \theta + 2 = 0$  for  $0^\circ < \theta < 360^\circ$ . [4]

- (b) Solve the equation  $\frac{1}{2}\sec\left(2\phi + \frac{\pi}{4}\right) = \frac{1}{\sqrt{3}}$  for  $-\pi < \phi < \pi$ , where  $\phi$  is in radians. Give your answers in terms of  $\pi$ . [5]

10 In this question all lengths are in centimetres.



The diagram shows a shaded shape. The arc  $AB$  is the major arc of a circle, centre  $O$ , radius 10. The line  $AB$  is of length 15, the line  $OC$  is of length 25 and the lengths of  $AC$  and  $BC$  are equal.

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

(b) Find the perimeter of the shaded shape. [4]

(c) Find the area of the shaded shape.

[5]

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