



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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4037/12

May/June 2020

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. 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*

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

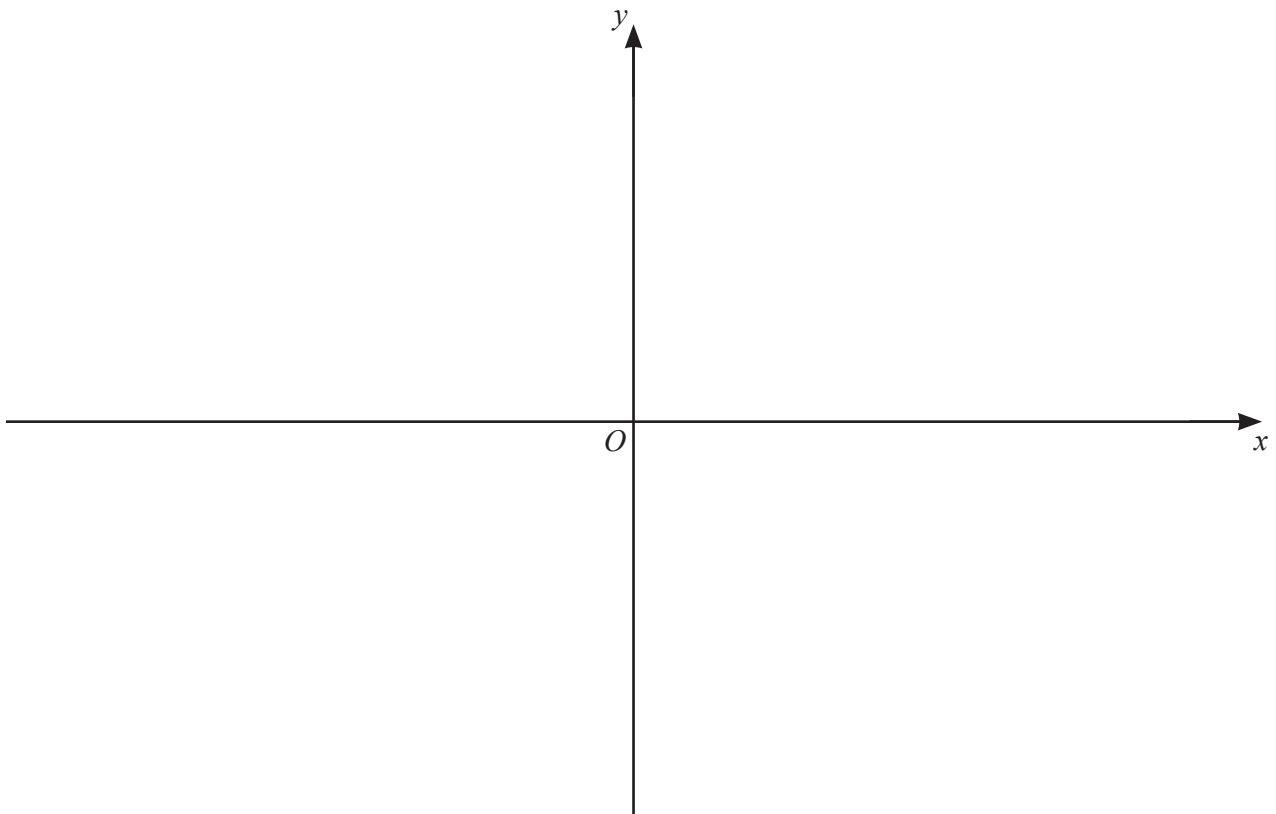
Formulae for $\triangle ABC$

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

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

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

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



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

The radius, r cm, of a sphere is increasing at the rate of 0.5 cm s^{-1} . Find, in terms of π , the rate of change of the volume of the sphere when $r = 0.25$. [4]

- 3 (a) Find the first 3 terms in the expansion of $\left(4 - \frac{x}{16}\right)^6$ in ascending powers of x . Give each term in its simplest form. [3]

- (b) Hence find the term independent of x in the expansion of $\left(4 - \frac{x}{16}\right)^6 \left(x - \frac{1}{x}\right)^2$. [3]

- 4 (a) (i) Find how many different 5-digit numbers can be formed using the digits 1, 2, 3, 5, 7 and 8, if each digit may be used only once in any number. [1]
- (ii) How many of the numbers found in **part (i)** are not divisible by 5? [1]
- (iii) How many of the numbers found in **part (i)** are even and greater than 30 000? [4]
- (b) The number of combinations of n items taken 3 at a time is 6 times the number of combinations of n items taken 2 at a time. Find the value of the constant n . [4]

5 $f : x \mapsto (2x+3)^2$ for $x > 0$

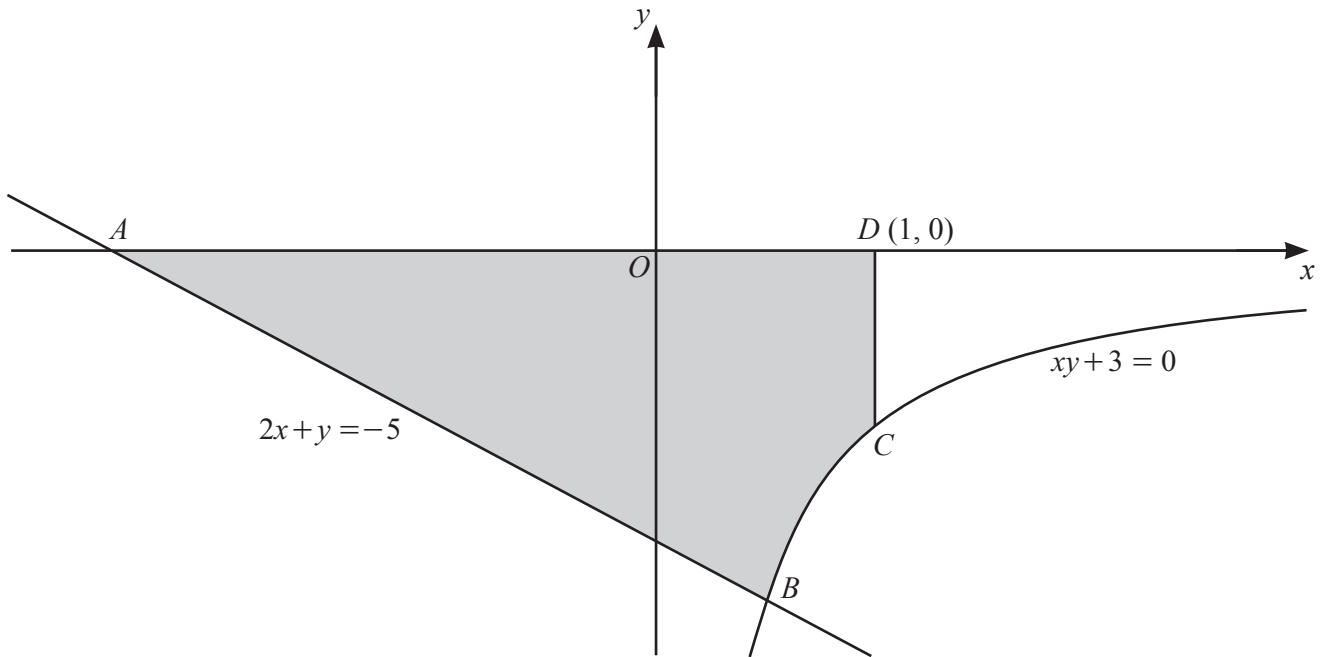
(a) Find the range of f . [1]

(b) Explain why f has an inverse. [1]

(c) Find f^{-1} . [3]

(d) State the domain of f^{-1} . [1]

(e) Given that $g : x \mapsto \ln(x+4)$ for $x > 0$, find the exact solution of $fg(x) = 49$. [3]



The diagram shows the straight line $2x + y = -5$ and part of the curve $xy + 3 = 0$. The straight line intersects the x -axis at the point A and intersects the curve at the point B . The point C lies on the curve. The point D has coordinates $(1, 0)$. The line CD is parallel to the y -axis.

(a) Find the coordinates of each of the points A and B .

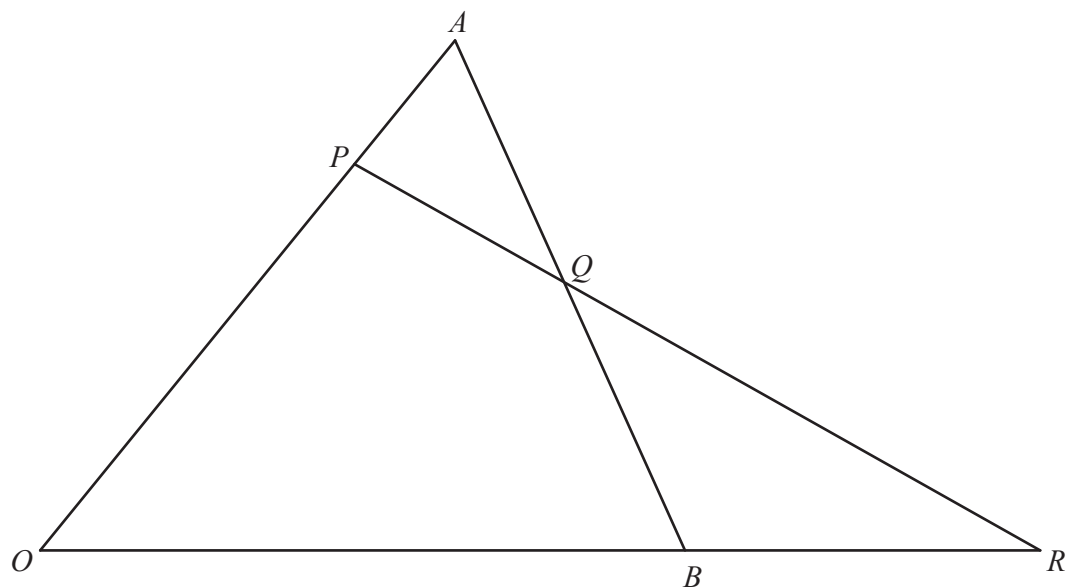
[3]

- (b) Find the area of the shaded region, giving your answer in the form $p + \ln q$, where p and q are positive integers. [6]

- 7 (a) Given that $y = (x^2 - 1)\sqrt{5x + 2}$, show that $\frac{dy}{dx} = \frac{Ax^2 + Bx + C}{2\sqrt{5x + 2}}$, where A , B and C are integers. [5]

- (b) Find the coordinates of the stationary point of the curve $y = (x^2 - 1)\sqrt{5x + 2}$, for $x > 0$. Give each coordinate correct to 2 significant figures. [3]

- (c) Determine the nature of this stationary point. [2]



The diagram shows a triangle OAB such that $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$. The point P lies on OA such that $OP = \frac{3}{4}OA$. The point Q is the mid-point of AB . The lines OB and PQ are extended to meet at the point R . Find, in terms of $\mathbf{a}$ and $\mathbf{b}$,

(a) $\overrightarrow{AB}$, [1]

(b) $\overrightarrow{PQ}$. Give your answer in its simplest form. [3]

It is given that $n\overrightarrow{PQ} = \overrightarrow{QR}$ and $\overrightarrow{BR} = k\mathbf{b}$, where n and k are positive constants.

(c) Find $\overrightarrow{QR}$ in terms of n , $\mathbf{a}$ and $\mathbf{b}$. [1]

(d) Find $\overrightarrow{QR}$ in terms of k , $\mathbf{a}$ and $\mathbf{b}$. [2]

(e) Hence find the value of n and of k . [3]

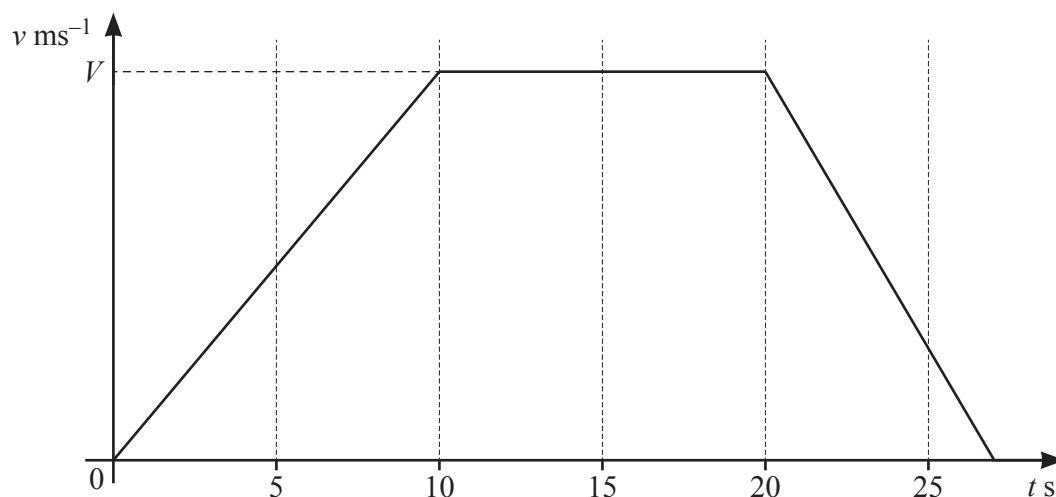
- 9 (a) A particle P moves in a straight line such that its displacement, x m, from a fixed point O at time t s is given by $x = 10 \sin 2t - 5$.

(i) Find the speed of P when $t = \pi$. [1]

(ii) Find the value of t for which P is first at rest. [2]

(iii) Find the acceleration of P when it is first at rest. [2]

(b)



The diagram shows the velocity–time graph for a particle Q travelling in a straight line with velocity $v \text{ ms}^{-1}$ at time $t \text{ s}$. The particle accelerates at 3.5 ms^{-2} for the first 10 s of its motion and then travels at constant velocity, $V \text{ ms}^{-1}$, for 10 s. The particle then decelerates at a constant rate and comes to rest. The distance travelled during the interval $20 \leq t \leq 25$ is 112.5 m.

(i) Find the value of V . [1]

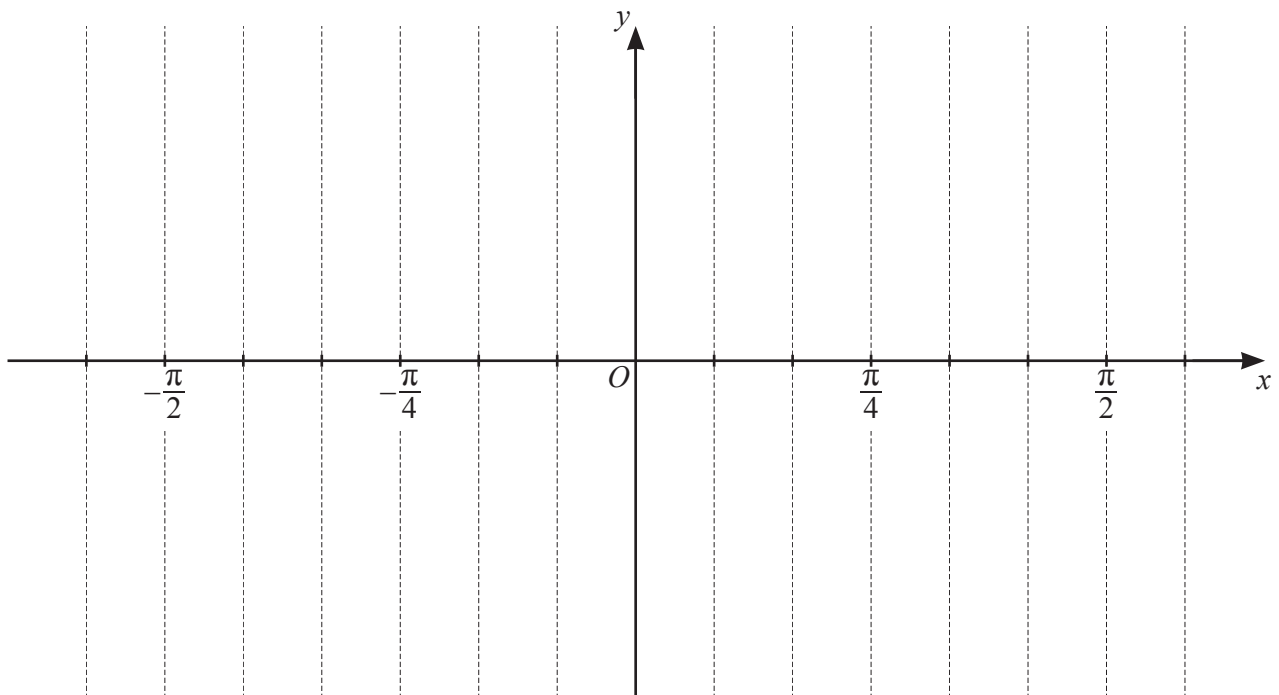
(ii) Find the velocity of Q when $t = 25$. [3]

(iii) Find the value of t when Q comes to rest. [3]

Question 10 is printed on the next page.

- 10 (a) Solve $\tan 3x = -1$ for $-\frac{\pi}{2} \leq x \leq \frac{\pi}{2}$ radians, giving your answers in terms of π . [4]

- (b) Use your answers to **part (a)** to sketch the graph of $y = 4 \tan 3x + 4$ for $-\frac{\pi}{2} \leq x \leq \frac{\pi}{2}$ radians on the axes below. Show the coordinates of the points where the curve meets the axes.



[3]

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