

CANDIDATE
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MATHEMATICS

9709/11

Paper 1 Pure Mathematics 1 (P1)

May/June 2018

1 hour 45 minutes

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

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Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.

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At the end of the examination, fasten all your work securely together.

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The total number of marks for this paper is 75.

This document consists of **19** printed pages and **1** blank page.



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- 1 (i) Find the first three terms in the expansion, in ascending powers of x , of $(1 - 2x)^5$. [2]

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- (ii) Given that the coefficient of x^2 in the expansion of $(1 + ax + 2x^2)(1 - 2x)^5$ is 12, find the value of the constant a . [3]

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- 2 A point is moving along the curve $y = 2x + \frac{5}{x}$ in such a way that the x -coordinate is increasing at a constant rate of 0.02 units per second. Find the rate of change of the y -coordinate when $x = 1$. [4]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 3** A curve is such that $\frac{dy}{dx} = \frac{12}{(2x+1)^2}$. The point (1, 1) lies on the curve. Find the coordinates of the point at which the curve intersects the x -axis. [6]

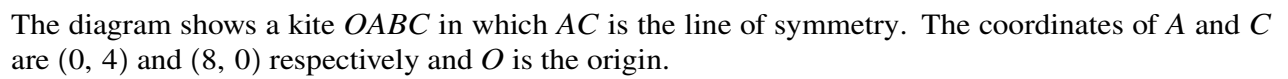
[illegible]

4 (i) Prove the identity $(\sin \theta + \cos \theta)(1 - \sin \theta \cos \theta) \equiv \sin^3 \theta + \cos^3 \theta$. [3]

[illegible]

(ii) Hence solve the equation $(\sin \theta + \cos \theta)(1 - \sin \theta \cos \theta) = 3 \cos^3 \theta$ for $0^\circ \leq \theta \leq 360^\circ$. [3]

[illegible]

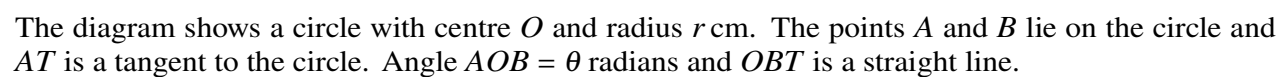


[4]

[illegible]

[3]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.



- [illegible]

- (ii)** In the case where $r = 3$ and $\theta = 1.2$, find the perimeter of the shaded region. [4]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dotted lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, leaving ample room for writing practice. There is no text or other markings on the page.

$$\overrightarrow{OA} = \begin{pmatrix} 1 \\ -3 \\ 2 \end{pmatrix}, \quad \overrightarrow{OB} = \begin{pmatrix} -1 \\ 3 \\ 5 \end{pmatrix} \quad \text{and} \quad \overrightarrow{OC} = \begin{pmatrix} 3 \\ 1 \\ -2 \end{pmatrix}.$$

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- [illegible]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

- 8** (a) A geometric progression has a second term of 12 and a sum to infinity of 54. Find the possible values of the first term of the progression. [4]

[illegible]

- (b) The n th term of a progression is $p + qn$, where p and q are constants, and S_n is the sum of the first n terms.

(i) Find an expression, in terms of p , q and n , for S_n . [3]

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(ii) Given that $S_4 = 40$ and $S_6 = 72$, find the values of p and q . [2]

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9 Functions f and g are defined for $x \in \mathbb{R}$ by

$$f : x \mapsto \frac{1}{2}x - 2,$$

$$g : x \mapsto 4 + x - \frac{1}{2}x^2.$$

(i) Find the points of intersection of the graphs of $y = f(x)$ and $y = g(x)$. [3]

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(ii) Find the set of values of x for which $f(x) > g(x)$. [2]

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(iii) Find an expression for $fg(x)$ and deduce the range of fg .

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The function h is defined by $h : x \mapsto 4 + x - \frac{1}{2}x^2$ for $x \geq k$.

(iv) Find the smallest value of k for which h has an inverse.

[2]

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10 The curve with equation $y = x^3 - 2x^2 + 5x$ passes through the origin.

(i) Show that the curve has no stationary points. [3]

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(ii) Denoting the gradient of the curve by m , find the stationary value of m and determine its nature. [5]

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MATHEMATICS

9709/12

Paper 1 Pure Mathematics 1 (P1)

May/June 2018

1 hour 45 minutes

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The total number of marks for this paper is 75.

This document consists of **20** printed pages.



- 1 The coefficient of x^2 in the expansion of $\left(2 + \frac{x}{2}\right)^6 + (a + x)^5$ is 330. Find the value of the constant a . [5]

[illegible]

2 The equation of a curve is $y = x^2 - 6x + k$, where k is a constant.

(i) Find the set of values of k for which the whole of the curve lies above the x -axis. [2]

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(ii) Find the value of k for which the line $y + 2x = 7$ is a tangent to the curve. [3]

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- 3** A company producing salt from sea water changed to a new process. The amount of salt obtained each week increased by 2% of the amount obtained in the preceding week. It is given that in the first week after the change the company obtained 8000 kg of salt.

(i) Find the amount of salt obtained in the 12th week after the change. [3]

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(ii) Find the total amount of salt obtained in the first 12 weeks after the change. [2]

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- 4 The function f is such that $f(x) = a + b \cos x$ for $0 \leq x \leq 2\pi$. It is given that $f(\frac{1}{3}\pi) = 5$ and $f(\pi) = 11$.

(i) Find the values of the constants a and b . [3]

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(ii) Find the set of values of k for which the equation $f(x) = k$ has no solution. [3]

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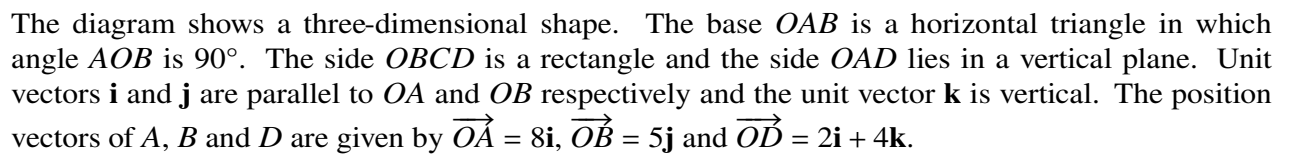
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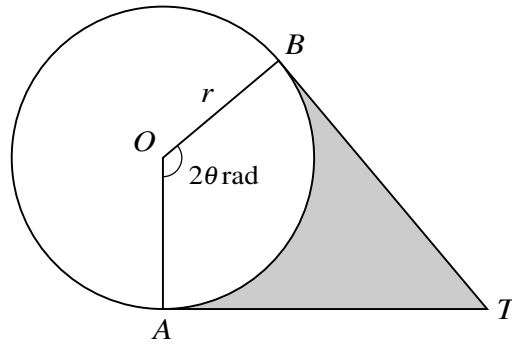
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- This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

[4]

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The diagram shows points A and B on a circle with centre O and radius r . The tangents to the circle at A and B meet at T . The shaded region is bounded by the minor arc AB and the lines AT and BT . Angle AOB is 2θ radians.

- (i) In the case where the area of the sector AOB is the same as the area of the shaded region, show that $\tan \theta = 2\theta$. [3]

[illegible]

[illegible]

7 The function f is defined by $f : x \mapsto 7 - 2x^2 - 12x$ for $x \in \mathbb{R}$.

(i) Express $7 - 2x^2 - 12x$ in the form $a - 2(x + b)^2$, where a and b are constants. [2]

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(ii) State the coordinates of the stationary point on the curve $y = f(x)$. [1]

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[illegible]

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- 8** Points A and B have coordinates (h, h) and $(4h + 6, 5h)$ respectively. The equation of the perpendicular bisector of AB is $3x + 2y = k$. Find the values of the constants h and k . [7]

[illegible]

- 9** A curve is such that $\frac{dy}{dx} = \sqrt{(4x+1)}$ and $(2, 5)$ is a point on the curve.

(i) Find the equation of the curve.

[4]

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- (ii) A point P moves along the curve in such a way that the y -coordinate is increasing at a constant rate of 0.06 units per second. Find the rate of change of the x -coordinate when P passes through $(2, 5)$. [2]

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- (iii) Show that $\frac{d^2y}{dx^2} \times \frac{dy}{dx}$ is constant. [2]

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- 10** (i) Solve the equation $2 \cos x + 3 \sin x = 0$, for $0^\circ \leq x \leq 360^\circ$. [3]

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- (ii) Sketch, on the same diagram, the graphs of $y = 2 \cos x$ and $y = -3 \sin x$ for $0^\circ \leq x \leq 360^\circ$. [3]

- (iii) Use your answers to parts (i) and (ii) to find the set of values of x for $0^\circ \leq x \leq 360^\circ$ for which $2 \cos x + 3 \sin x > 0$. [2]

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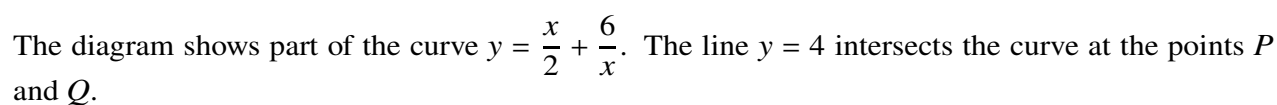
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- [illegible]

- (ii) Find, showing all necessary working, the volume obtained when the shaded region is rotated through 360° about the x -axis. Give your answer in terms of π . [6]

[illegible]

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- 1** Express $3x^2 - 12x + 7$ in the form $a(x + b)^2 + c$, where a , b and c are constants. [3]

[illegible]

- 2** Find the coefficient of $\frac{1}{x}$ in the expansion of $\left(x - \frac{2}{x}\right)^5$. [3]

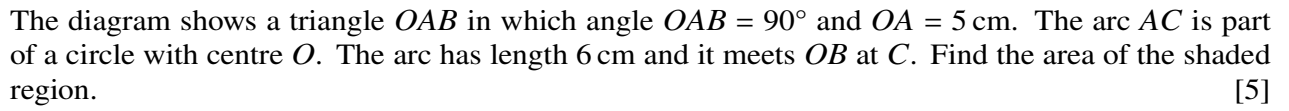
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- 3 The common ratio of a geometric progression is 0.99. Express the sum of the first 100 terms as a percentage of the sum to infinity, giving your answer correct to 2 significant figures. [5]

[illegible]

- 4** A curve with equation $y = f(x)$ passes through the point $A(3, 1)$ and crosses the y -axis at B . It is given that $f'(x) = (3x - 1)^{-\frac{1}{3}}$. Find the y -coordinate of B . [6]

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[illegible]

- 6** The coordinates of points A and B are $(-3k - 1, k + 3)$ and $(k + 3, 3k + 5)$ respectively, where k is a constant ($k \neq -1$).

(i) Find and simplify the gradient of AB , showing that it is independent of k . [2]

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(ii) Find and simplify the equation of the perpendicular bisector of AB . [5]

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- 7 (a) (i) Express $\frac{\tan^2 \theta - 1}{\tan^2 \theta + 1}$ in the form $a \sin^2 \theta + b$, where a and b are constants to be found. [3]

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- (ii) Hence, or otherwise, and showing all necessary working, solve the equation

$$\frac{\tan^2 \theta - 1}{\tan^2 \theta + 1} = \frac{1}{4}$$

for $-90^\circ \leq \theta \leq 0^\circ$.

[2]

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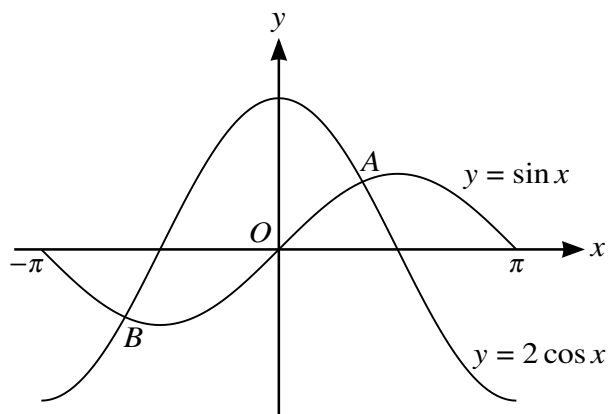
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(b)



The diagram shows the graphs of $y = \sin x$ and $y = 2 \cos x$ for $-\pi \leq x \leq \pi$. The graphs intersect at the points A and B .

(i) Find the x -coordinate of A .

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(ii) Find the y -coordinate of B .

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- 8** (i) The tangent to the curve $y = x^3 - 9x^2 + 24x - 12$ at a point A is parallel to the line $y = 2 - 3x$. Find the equation of the tangent at A . [6]

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- (ii) The function f is defined by $f(x) = x^3 - 9x^2 + 24x - 12$ for $x > k$, where k is a constant. Find the smallest value of k for f to be an increasing function. [2]

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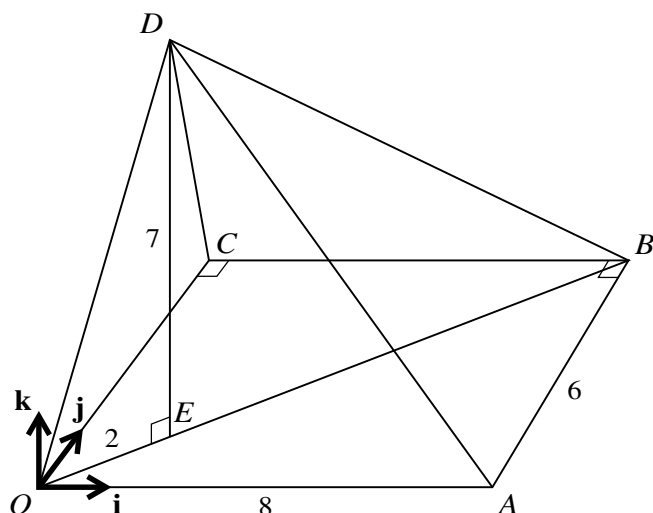
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The diagram shows a pyramid $OABCD$ with a horizontal rectangular base $OABC$. The sides OA and AB have lengths of 8 units and 6 units respectively. The point E on OB is such that $OE = 2$ units. The point D of the pyramid is 7 units vertically above E . Unit vectors $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$ are parallel to OA , OC and ED respectively.

- (i) Show that $\overrightarrow{OE} = 1.6\mathbf{i} + 1.2\mathbf{j}$. [2]

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- (ii) Use a scalar product to find angle BDO . [7]

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- 10** The one-one function f is defined by $f(x) = (x - 2)^2 + 2$ for $x \geq c$, where c is a constant.

(i) State the smallest possible value of c .

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In parts (ii) and (iii) the value of c is 4.

(ii) Find an expression for $f^{-1}(x)$ and state the domain of f^{-1} .

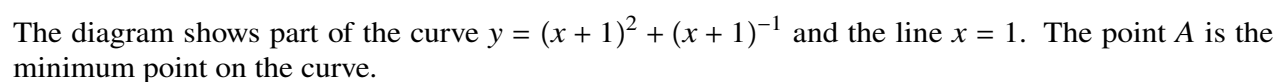
[3]

[illegible]

(iii) Solve the equation $\text{ff}(x) = 51$, giving your answer in the form $a + \sqrt{b}$.

[5]

[illegible]



- [illegible]

- (ii)** Find, showing all necessary working, the volume obtained when the shaded region is rotated through 360° about the x -axis. [6]

[illegible]

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