Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Differentiation

Time allowed: 1 hour 50 minutes

Subject code **0606**

Additional Mathematics

Questions from Paper 1 and Paper 2

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.
Questions 1, 6-9 (Paper 1): no calculator.
Questions 2-5, 10 (Paper 2): calculator allowed.

Total marks

/ 73

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.
- Unless a question says otherwise, give answers that are not exact to 3 significant figures, and angles in degrees to 1 decimal place.

Information

- This paper has 10 questions worth 73 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 The rate of change of a variable x with respect to time t is $4\cos^2 t$.

(i) Find the rate of change of x with respect to t when $t = \frac{\pi}{6}$. [1]

The rate of change of a variable y with respect to time t is $3\sin t$.

(ii) Using your result from part **(i)**, find the rate of change of y with respect to x when $t = \frac{\pi}{6}$. [3]

Connected rates of change and small increments Click for more variations

2 Variables x and y are such that $y = \cos x \sin^2 x$. Use differentiation to find the approximate change in y as x increases from 3 to $3 + h$, where h is small. [5]

Connected rates of change and small increments Click for more variations

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3 A curve has equation $y = \frac{x^3}{\sin 2x}$. Find

(i) $\frac{\mathrm{d}y}{\mathrm{d}x}$, [3]

(ii) the equation of the tangent to the curve at the point where $x = \frac{\pi}{4}$. [3]

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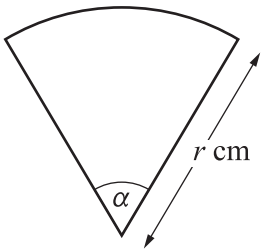
Differentiation, tangents, normals and stationary points Click for more variations

4 A curve has equation $y = 2x\cos x$. The normal to the curve at $(\pi, -2\pi)$ meets the x-axis and y-axis at points P and Q. Find the exact area of triangle POQ. [7]

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Differentiation, tangents, normals and stationary points Click for more variations

5 The diagram shows a design for a logo. The logo is a sector of a circle, radius r cm, with angle α radians.



The area of the logo is $9\,\text{cm}^2$.

(a) Show that the perimeter, P cm, of the logo is given by

$$P = 2r + \frac{18}{r}.$$ [3]

(b) Given that r can vary, find the stationary value of P and determine its nature. [5]

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Maxima and minima problems Click for more variations

6 The normal to the curve $y = x^3 + \frac{3}{2}x^2 - 2x + 1$ at the point where $x = 0$ cuts the curve again at two other points.

Find the x-coordinates of these two points. [8]

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Differentiation, tangents, normals and stationary points Click for more variations

7 **(i)** Write $\ln\left(\frac{2x+1}{2x-1}\right)$ as the difference of two logarithms. [1]

A curve has equation $y = \ln\left(\frac{2x+1}{2x-1}\right) + 4x$ for $x > \frac{1}{2}$.

(ii) Using your answer to part **(i)** show that $\frac{dy}{dx} = \frac{ax^2+b}{4x^2-1}$, where a and b are integers. [4]

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(iii) Hence find the x-coordinate of the stationary point on the curve. [2]

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

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Differentiation, tangents, normals and stationary points Click for more variations

8 A curve has equation $y = \dfrac{(2x+1)^{\frac{3}{2}}}{x+5}$ for $x \geqslant 0$.

(a) Show that $\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{(2x+1)^{\frac{1}{2}}}{(x+5)^2}(Ax+B)$, where A and B are integers to be found. [4]

(b) Show that there are no stationary points on this curve. [1]

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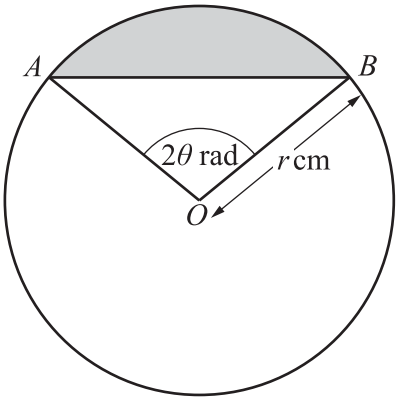
(c) Find the approximate change in y when x increases from 1 to $1+p$, where p is small. [2]

(d) Given that when $x = 1$ the rate of change in x is 2.5 units per second, find the corresponding rate of change in y. [2]

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Differentiation, tangents, normals and stationary points Click for more variations

9



The diagram shows a circle, centre O, radius r cm. The points A and B lie on the circle such that angle $AOB = 2\theta$ radians.

(i) Find, in terms of r and θ, an expression for the length of the chord AB. [1]

(ii) Given that the perimeter of the shaded region is 20 cm, show that $r = \dfrac{10}{\theta + \sin\theta}$. [2]

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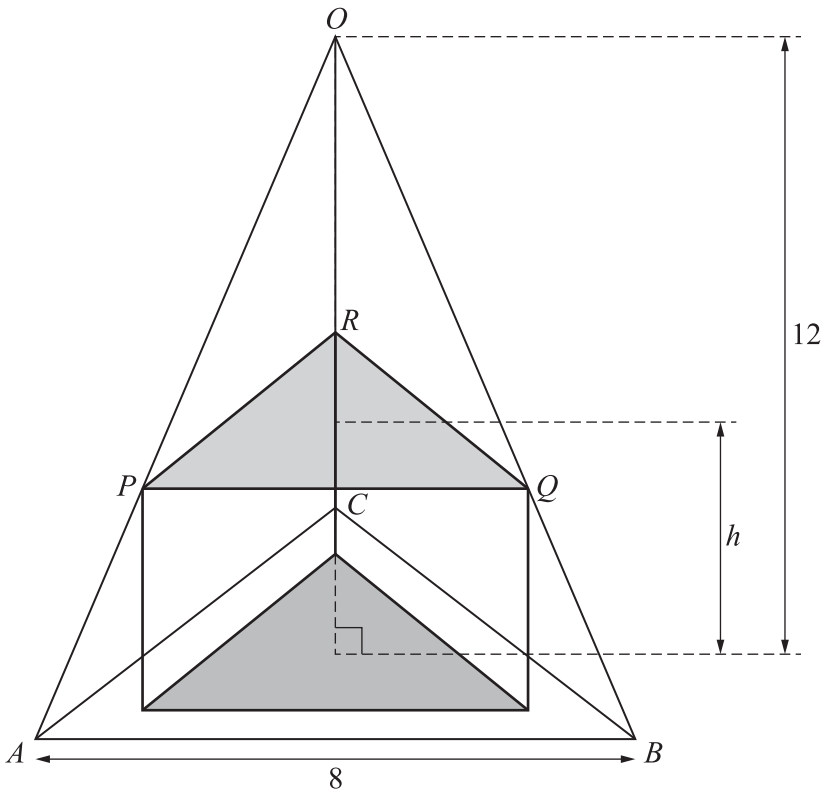
(iii) Given that r and θ can vary, find the value of $\frac{\mathrm{d}r}{\mathrm{d}\theta}$ when $\theta = \frac{\pi}{6}$. [4]

(iv) Given that r is increasing at the rate of $15\,\mathrm{cm\,s^{-1}}$, find the corresponding rate of change of θ when $\theta = \frac{\pi}{6}$. [3]

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Differentiation, tangents, normals and stationary points Click for more variations

10 In this question all lengths are in centimetres.



The diagram shows a right triangular prism of height h inside a right pyramid.
The pyramid has a height of 12 and a base that is an equilateral triangle, ABC, of side 8.
The base of the prism sits on the base of the pyramid.
Points P, Q and R lie on the edges OA, OB and OC, respectively, of the pyramid $OABC$.
Pyramids $OABC$ and $OPQR$ are similar.

(a) Show that the volume, V, of the triangular prism is given by $V = \frac{\sqrt{3}}{9}(ah^3 + bh^2 + ch)$ where a, b and c are integers to be found. [4]

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(b) It is given that, as h varies, V has a maximum value. Find the value of h that gives this maximum value of V. [3]

Maxima and minima problems Click for more variations

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