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

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Connected rates of change and small changes

Time allowed: 1 hour 15 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 2, 9 (Paper 1): no calculator.
Questions 1, 3-8, 10 (Paper 2): calculator allowed.

Total marks

/ 50

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 50 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 **(i)** Given that $y = \sin 3x$, find $\frac{dy}{dx}$. [1]

(ii) Hence find the approximate increase in y as x increases from $\frac{\pi}{9}$ to $\frac{\pi}{9} + p$, where p is small. [2]

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2 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]

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3 The total surface area, A cm², of a solid cylinder with radius r cm and height 5 cm is given by $A = 2\pi r^2 + 10\pi r$. Given that r is increasing at a rate of $\frac{0.2}{\pi}$ cm s^{-1}, find the rate of increase of A when r is 6. [4]

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4 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]

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5 Variables x and y are related by the equation $y = 1 + \frac{2}{x} + \frac{1}{x^2}$ where $x > 0$. Use differentiation to find the approximate change in x when y increases from 4 by the small amount 0.01. [5]

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6 A cylinder, open at both ends, has base radius r cm and height $4r$ cm. Its curved surface area is S cm^2.

Given that r varies with time t, find S at the instant when $\frac{\mathrm{d}S}{\mathrm{d}t} = 6\frac{\mathrm{d}r}{\mathrm{d}t}$. [5]

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7 Variables x and y are such that $y = \dfrac{(1+\sin 3x)^4}{\sqrt{x}}$. Use differentiation to find the approximate change in y when x increases from 1.9 to $1.9+h$, where h is small. [6]

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8 A cube of side x cm has surface area $S\,\text{cm}^2$. The volume, $V\,\text{cm}^3$, of the cube is increasing at a rate of $480\,\text{cm}^3\text{s}^{-1}$. Find, at the instant when $V = 512$,

(a) the rate of increase of x, [4]

(b) the rate of increase of S. [2]

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9 It is given that $y = \dfrac{\ln(3x^2 - 1)}{x + 2}$, for $x > \dfrac{1}{\sqrt{3}}$. When $x = 1$, y is increasing at the rate of h units per second. Find, in terms of h, the corresponding rate of change in x, giving your answer in exact form.

[6]

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10 Variables x and y are related by the equation $y = 2 + \tan(1 - x)$ where $0 \leqslant x \leqslant \frac{\pi}{2}$. Given that x is increasing at a constant rate of 0.04 radians per second, find the corresponding rate of change of y when $y = 3$. [6]

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