INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- Write your answer to each question in the space provided in the Printed Answer Book. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer all the questions.
- Do not write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets [ ] at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive no marks unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is 72.
- The Printed Answer Book consists of 16 pages. The Question Paper consists of 8 pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

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Section A (36 marks)

1. Fig. 1 shows part of the curve \( y = e^{2x} \cos x \).

2. Find the coordinates of the turning point P. [6]

3. Find \( \int \sqrt{2x - 1} \, dx \). [4]

4. Find the exact value of \( \int \frac{x^3 \ln x \, dx}{x} \). [5]

4. Fig. 4 shows a cone with its axis vertical. The angle between the axis and the slant edge is 45°. Water is poured into the cone at a constant rate of 5 cm³ per second. At time \( t \) seconds, the height of the water surface above the vertex O of the cone is \( h \) cm, and the volume of water in the cone is \( V \) cm³.

   \[ V \text{ in terms of } h. \]

   Hence find the rate at which the height of water is increasing when the height is 10 cm. [You are given that the volume \( V \) of a cone of height \( h \) and radius \( r \) is \( V = \frac{1}{3} \pi r^2 h \).] [5]

5. A curve has implicit equation \( y^2 + 2x \ln y = x^2 \).

   Verify that the point (1, 1) lies on the curve, and find the gradient of the curve at this point. [6]
6 Solve each of the following equations, giving your answers in exact form.

(i) \( \arcsin x - \pi = 0 \). \[2\]

(ii) \( \arcsin x = \arccos x \). \[2\]

7 (i) The function \( f(x) \) is defined by

\[
f(x) = \frac{1-x}{1+x}, \quad x \neq -1.
\]

Show that \( f(f(x)) = x \).

Hence write down \( f^{-1}(x) \). \[3\]

(ii) The function \( g(x) \) is defined for all real \( x \) by

\[
g(x) = \frac{1-x^2}{1+x^2}.
\]

Prove that \( g(x) \) is even. Interpret this result in terms of the graph of \( y = g(x) \). \[3\]
Section B (36 marks)

8 Fig. 8 shows the line $y = 1$ and the curve $y = f(x)$, where $f(x) = \frac{(x-2)^2}{x}$. The curve touches the $x$-axis at $P(2, 0)$ and has another turning point at the point $Q$.

(i) Show that $f'(x) = 1 - \frac{4}{x^2}$, and find $f''(x)$.

Hence find the coordinates of $Q$ and, using $f''(x)$, verify that it is a maximum point. [7]

(ii) Verify that the line $y = 1$ meets the curve $y = f(x)$ at the points with $x$-coordinates 1 and 4. Hence find the exact area of the shaded region enclosed by the line and the curve. [6]

The curve $y = f(x)$ is now transformed by a translation with vector $\left(-\frac{1}{2}, -1\right)$. The resulting curve has equation $y = g(x)$.

(iii) Show that $g(x) = \frac{x^2 - 3x}{x+1}$. [3]

(iv) Without further calculation, write down the value of $\int_0^3 g(x) \, dx$, justifying your answer. [2]
Fig. 9 shows the curve \( y = f(x) \), where
\[
f(x) = (e^x - 2)^2 - 1, \quad x \in \mathbb{R}.
\]

The curve crosses the \( x \)-axis at \( O \) and \( P \), and has a turning point at \( Q \).

(i) Find the exact \( x \)-coordinate of \( P \). \[2\]

(ii) Show that the \( x \)-coordinate of \( Q \) is \( \ln 2 \) and find its \( y \)-coordinate. \[4\]

(iii) Find the exact area of the region enclosed by the curve and the \( x \)-axis. \[5\]

The domain of \( f(x) \) is now restricted to \( x \geq \ln 2 \).

(iv) Find the inverse function \( f^{-1}(x) \). Write down its domain and range, and sketch its graph on the copy of Fig. 9. \[7\]

END OF QUESTION PAPER
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