# Core Mathematics C4 Advanced Level 

## Paper B

## Time: 1 hour 30 minutes

## Instructions and Information

- Full marks may be obtained for answers to ALL questions.
- The formulae booklet, available from AQA, may be used.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.
- You may use a graphical calculator in this paper.
- The total number of marks for this paper is 75 .


## Advice to Candidates

You must show sufficient working to make your methods clear to an examiner. Answers without working may gain no credit.

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1. A curve has equation $(x-2)(y+5)=12$.
(a) Find an expression for $\frac{\mathrm{d} y}{\mathrm{~d} x}$ in terms of $x$ and $y$.
(b) Find the equation of the normal to the curve at the point $(4,1)$.
(3 marks)
2. Simplify

$$
\begin{equation*}
\frac{4 x^{2}-25}{x^{2}+x} \div \frac{2 x^{2}-x-10}{x^{2}+3 x+2} \tag{5marks}
\end{equation*}
$$

3. (a) Expand $(1+8 x)^{\frac{1}{2}}$ in ascending powers of $x$, up to and including the term in $x^{3}$.
(b) State the set of values of $x$ for which the expansion is valid.
(c) In the expansion of

$$
(1+a x)(1+8 x)^{\frac{1}{2}}
$$

the coefficients of the $x$ term and the $x^{2}$ term are equal.
Find the value of $a$ and hence find the coefficient of the term in $x^{3}$. (6 marks)
4. A radioactive substance is decaying exponentially. After $t$ years its mass $m$ grams is given by

$$
m=500 \mathrm{e}^{-0.02 t}
$$

(a) Find the value of $m$ when $t=10$.
(b) Find the value of $t$ when $m=300$.
(c) Find the rate at which the mass is decreasing when $t=1$.
5. (a) Given that $\cot x=\frac{4}{3}$ and that $x$ is a reflex angle, find the exact value of $\operatorname{cosec} x$
(b) Find the exact value of $\cos 2 x$.
(c) Find the exact value of $\tan 2 x$.
6. The parametric equations of a curve are

$$
x=\sin \theta, \quad y=2 \cos ^{2} \theta, \quad 0 \leq \theta \leq \frac{\pi}{2}
$$

(a) Find the equation of the tangent to the curve at the point where $\theta=\frac{\pi}{6}$.
(b) Find the cartesian equation of the curve.
7. (a) Express $\frac{1}{(y-1) y}$ in partial fractions.
(b) Given that $y=5$ when $x=0$, show that the solution of the differential equation

$$
\frac{\mathrm{d} y}{\mathrm{~d} x}=\left(y^{2}-y\right) \cos x
$$

may be written as $y=\frac{5}{5-4 \mathrm{e}^{\sin x}}$
(7 marks)
8. The position vectors of three points are

A: $\quad 5 \mathbf{i}+6 \mathbf{j}+2 \mathbf{k}$
B: $7 \mathbf{i}+9 \mathbf{j}+3 \mathbf{k}$
C: $\quad 6 \mathbf{i}+6 \mathbf{j}+6 \mathbf{k}$
(a) Find a vector equation of the line $A B$
(b) Show that the vector $12 \mathbf{i}-7 \mathbf{j}-3 \mathbf{k}$ is perpendicular to the line $A C$. (2 marks)
(c) Find the angle $B A C$, giving your answer to the nearest degree. (4 marks)
9. (a) Express $\mathrm{f}(x)=\sqrt{3} \sin x+\cos x$ in the form $R \cos (x-\alpha)$, where $R>0$ and $0<\alpha<\frac{\pi}{2}$. The values of $R$ and $\alpha$ are to be given exactly.
(b) Hence solve the equation

$$
\sqrt{3} \sin x+\cos x=\sqrt{2}, \quad \text { where } \quad 0<x<\pi . \quad \text { (6 marks) }
$$

(c) You are given that $y=2 \mathrm{f}(x)+1$. State the maximum and minimum values of $y$.

