

NORTHBROOKS SECONDARY SCHOOL
Preliminary Examination 2026
Secondary 4



CANDIDATE
NAME

CLASS

REGISTER
NUMBER

ADDITIONAL MATHEMATICS

4049/02

Paper 2

24 August 2026

2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page.

Write in dark blue or black pen on both sides of the paper.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions.

The use of an approved scientific calculator is expected, where appropriate.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

You are reminded of the need for clear presentation in your answers.

The number of marks is given in brackets [] at the end of each question or part question.

The total marks for this paper is 90.

FOR EXAMINER'S USE										
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	90

DO NOT TURN THE PAGE UNTIL YOU ARE TOLD TO DO SO.

This document consists of **21** printed pages and **1** blank page.

[Turn over

Mathematical Formulae**1. ALGEBRA***Quadratic Equation*

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Binomial expansion

$$(a+b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \dots + \binom{n}{r}a^{n-r}b^r + \dots + b^n,$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{(n-r)!r!} = \frac{n(n-1)\dots(n-r+1)}{r!}$.

2. TRIGONOMETRY*Identities*

$$\sin^2 A + \cos^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\sin 2A = 2 \sin A \cos A$$

$$\cos 2A = \cos^2 A - \sin^2 A = 2 \cos^2 A - 1 = 1 - 2 \sin^2 A$$

$$\tan 2A = \frac{2 \tan A}{1 - \tan^2 A}$$

Formulae for $\triangle ABC$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$\Delta = \frac{1}{2} bc \sin A$$

1 Do not use a calculator in this question.

Given $\cos A = -\frac{2}{3}$ for $180^\circ < A < 360^\circ$, express $\cot A$ in the form of $h\sqrt{5}$ where h is a rational number.

[3]

2 (a) Given that $\tan A = 3 \tan B$, show that $\tan(A - B) = \frac{\sin 2B}{1 + 2 \sin^2 B}$. [4]

(b) (i) Solve, in terms of π , the equation $\cos 2x = \sqrt{3} \cos x - 1$ for $0 \leq x \leq 2\pi$. [4]

(ii) Hence solve, in terms of π , $\cos x = \sqrt{3} \cos \frac{x}{2} - 1$ for $0 \leq x \leq 2\pi$. [1]

- 3** A computer animation shows a cartoon person walking in a straight line such that t seconds after it passes through a fixed point O , its velocity, v cm/s, is given by $v = pt - 12t^2$, where p is a constant.
- (a)** Given that the cartoon person attains a maximum walking speed at 2 seconds, show that $p = 48$ and hence find the maximum speed. [3]
- (b)** Explain clearly why the total distance travelled by the person in the first 7 seconds is not obtained by finding the value of the displacement, s , when $t = 7$. [2]

- (c) Find the total distance travelled by the person in the first 7 seconds.

[4]

4 A circle C_1 , with centre C and radius r units, has equation $x^2 + y^2 - 4x + 8y - 16 = 0$.

(a) Find the coordinates of C and the value of r . [3]

(b) A circle C_2 is the reflection of the circle C_1 in the line $y = 3$.
Find the equation of the reflected circle C_2 and justify with reasons whether circles C_1 and C_2 intersect each other at 2 points, touch each other at 1 point or do not touch each other. [4]

- 5 (a) A formula for working out the braking distance d , for a vehicle travelling at speed v , is $d = av^3 + bv^2$, where a and b are constants. Values of d for different values of v have been collected. Explain how a straight line can be drawn to represent the formula, and state how the values of a and b could be obtained from the line. [4]

- (b) The value, $\$V$, of a limited edition watch has been increasing each year from 2016 to 2025. A watch trader claims that the increase is exponential and so can be modelled by an equation in the form

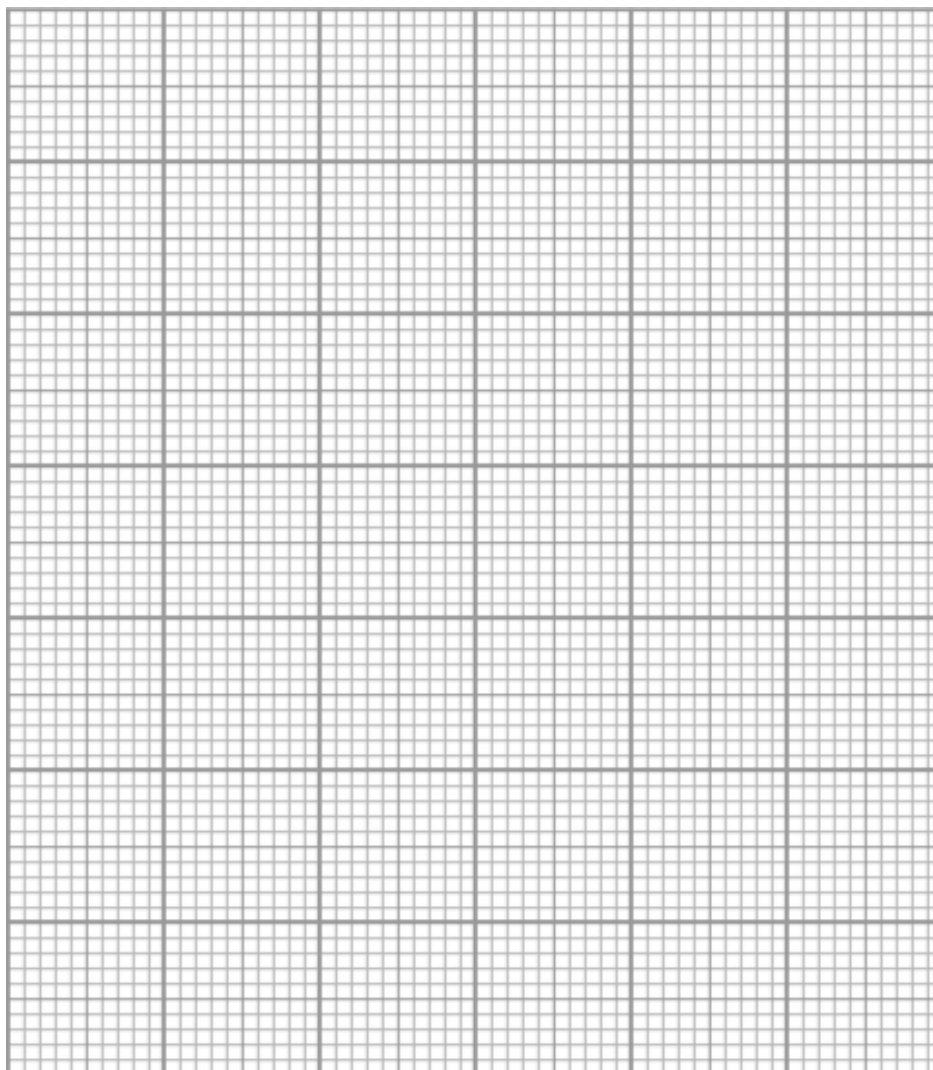
$$V = V_0 e^{kt},$$

where V_0 and k are constants and t is the time in years since 1st January 2016.

The table below gives values of V and t for some of the years from 2016 to 2025.

Year	2016	2019	2022	2025
t years	0	3	6	9
$\$V$	12000	12950	13900	15000

- (i) Plot $\ln V$ against t and draw a straight line graph to show that the model is valid for the years 2016 to 2025. [3]



(ii) Using your graph, estimate the value of V_o and k . [4]

(iii) Explain the significance of the value of V_o . [1]

(iv) Using your graph, estimate the value of the watch on 1st January 2023. [2]

- 6** **(a)** The equation of a curve is $y = x^2 - px + p^2 + 2$, where p is a constant.
Determine the nature of roots of the equation for all real values of p . [4]

- (b) Given that the curve $y = (k+3)x^2 + x - 1$ has a minimum point and it intersects the line $y = (k+1)x - 2$ at 2 distinct points, find the range of values of k . [4]

- 7 **(a)** Factorise $3(x - y)^3 + 24x^3$. [3]
- (b)** It is given that $f(x) = 4x^3 + ax^2 + bx + 3$, where a and b are constants, has a factor of $2x - 1$ and leaves a remainder of 18 when divided by $x + 1$.
- (i)** Find the values of a and b . [6]

- (ii) Using these values of a and b , solve $f(x) = 0$.

[3]

8 (a) Show that $\frac{d}{dx}\left(\frac{1}{6}\tan^3 2x\right) = \sec^4 2x - \sec^2 2x$. [3]

- (b) For a particular curve where $\frac{d^2y}{dx^2} = 9 \cos 3x - 5 \sin x$, the curve passes through the point $P\left(\frac{3\pi}{2}, \frac{15\pi}{2}\right)$ and the gradient of the curve at P is 8.
Find the equation of the curve. [6]

- 9 (a) Solve the equation $\log_9(25-10x) - \log_9 5 = \log_3(1-x)$. [4]

- (b) Show that the equation $2e^{2x+1} = e^{x+1} + 15e$ has only one solution and find its value in exact form.

[4]

10 (a) Given that $\int_2^k 3(2x-3)^{\frac{1}{2}} dx = 26$, find the value of k . [3]

(b) The gradient function of a curve is $-3(x-2)^2$.

(i) Find the x -coordinate of the stationary point of the curve and find the nature of this stationary point. [4]

It is given further that the normal to the curve at $x = 1$ cuts the x -axis at $(18, 0)$.

- (ii) Find the equation of the normal. [4]

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