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NORTHBROOKS SECONDARY SCHOOL
Preliminary Examination 2026
Secondary 4

NORTHBROOKS

CANDIDATE NAME

CLASS

REGISTER NUMBER

ADDITIONAL MATHEMATICS **4049/01**

Paper 1

13 August 2026

2 hours 15 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces at the top of this page.
Write in dark blue or black pen.
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.
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.
The use of an approved scientific calculator is expected, where appropriate.
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 number of marks for this paper is 90.

FOR EXAMINER'S USE													
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	
													90

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

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

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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

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

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

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 ΔABC

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$
$$a^2 = b^2 + c^2 - 2bc\cos A$$
$$\Delta = \frac{1}{2}bc\sin A$$

1 (a) Do not use a calculator in this question.

A circular cylinder of volume $\left(3\sqrt{5}-4\right)\pi$ cm^3 has a height of $\left(3+\sqrt{5}\right)$cm and a radius of r cm. Obtain an expression of r^2 in the form $\dfrac{a+b\sqrt{5}}{c}$, where a, b and c are constants. [4]

(b) The line $x - y = 3$ intersects the curve $x^2 - 3xy + y^2 + 19 = 0$ at points P and Q. Find the coordinates of P and of Q. [4]

2 **(a)** Two variables, x and y, are related by the equation $y=\frac{3}{4}\left(\frac{x}{12}-1\right)^6$.

Given that both x and y vary with time, find the value of y when the rate of change of y is 12 times the rate of change of x. [4]

(b) The function f is given by $\mathrm{f}(x)=\frac{e^{2x}}{1-x}$ for $x>1$.

Show that f is a decreasing function. [3]

3 **(a)** Express $\dfrac{7x^2 - 30x + 3}{(x-5)(x^2+3)}$ in partial fractions. [5]

(b) Differentiate $\ln\left(x^2+3\right)$ with respect to x. [1]

(c) Use your answers to **part (a)** and **(b)** to find $\int \frac{7x^2-30x+3}{(x-5)\left(x^2+3\right)}\,\mathrm{d}x$. [2]

4 The starting section of a roller coaster track can be modelled by the equation $y = 3t^2 - 24t + 103$, where y represents the height, in metres, of the first roller coaster car at time t seconds.

(a) Explain the meaning of the constant term 103 in this model. [1]

(b) Express $3t^2 - 24t + 103$ in the form of $a(t-h)^2 + k$. [2]

It is stated in safety requirements that roller coaster tracks must be at least 25 m above the ground.

(c) Determine, with reasons, whether this section of the roller coaster track has met the safety requirements. [1]

5 **(a)** By considering the general term in the binomial expansion of $\left(2x-\frac{1}{x^2}\right)^8$, explain why no term is independent of x in this expansion. [3]

(b) Find the first 3 terms in the expansion of $\left(2x-\frac{1}{x^2}\right)^8$ in descending powers of x. Give the terms in their simplest form. [2]

(c) Find the coefficient of x^2 in the expansion of $\left(\frac{1}{x^3}+5\right)\left(2x-\frac{1}{x^2}\right)^8$. [2]

6 **(a)** Given that $y = x^2\sqrt{1-3x}$, show that $\dfrac{dy}{dx} = \dfrac{x(4-15x)}{2\sqrt{1-3x}}$. [3]

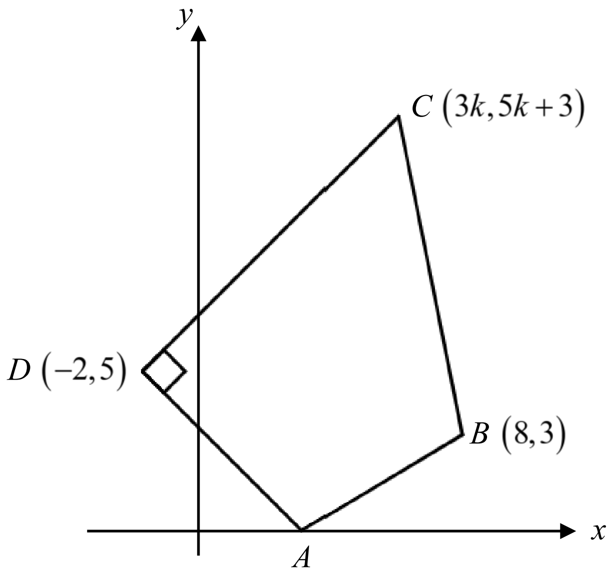
(b) Hence find the value of $\displaystyle\int_{-1}^{0} \frac{2+x(4-15x)}{2\sqrt{1-3x}}\,dx$. [3]

7 **(a)** State the amplitude and period of $y = 3\sin 2x + 1$. [2]

(b) Sketch the graph of $y = 3\sin 2x + 1$ for $0° \le x \le 360°$. [3]

(c) Given that $3\sin 2x + 1 = k$ has two solutions, state the possible values of k. [1]

8 The diagram shows a quadrilateral *ABCD*.
Point *B* is $(8,3)$, *C* is $(3k, 5k+3)$, *D* is $(-2,5)$ and *A* lies on the x – axis.
The equation of *AB* is $5y = 3x - 9$ and angle $ADC = 90°$.



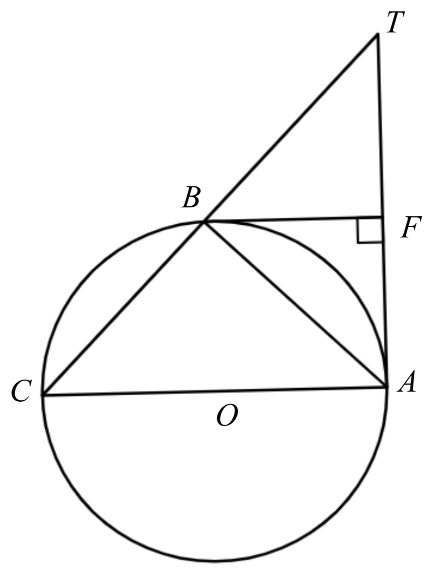
(a) Find the coordinates of *A*. [1]

(b) Show that $k = 2$. [4]

(c) Find the equation of the perpendicular bisector of *DC*. [3]

(d) Find the area of the quadrilateral *ABCD*. [2]

9



The diagram shows a circle, centre O, passing through the vertices of triangle ABC .
The tangent TA meets the diameter AC at point A.
CB produced and AF produced meet at T.

Prove that

(a) triangle BFA is similar to triangle ABC, [2]

(b) $AB^2 = AC \times BF$, [1]

(c) $AB^2 + TB^2 = (TC + AC)(TC - AC)$. [3]

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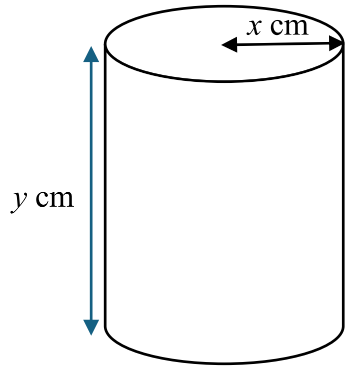


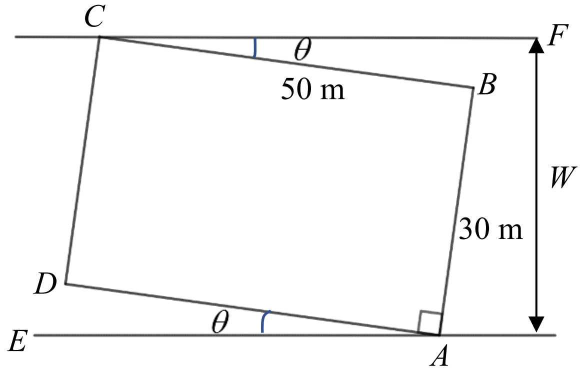
The diagram shows a closed container in the shape of a cylinder with radius x cm and height y cm.

(a) Given that the volume of the container is 32 cm^3, show that the total area, A cm^2, of the container is given by $A = 2\pi x^2 + \frac{64}{x}$. [3]

(b) Given that x can vary, find the value of x which gives a stationary value of A. [3]

(c) A company wishes to mass produce these containers using cardboard. Considering the cost of cardboard per square metre, explain why the company will be pleased with the dimensions of the container found in part **(b)**. [2]

11 The diagram shows a rectangular cargo ship $ABCD$ measuring 50 m by 30 m moving down a river. The cargo ship is stuck such that point C is in contact with one side of the river and the points C and F form a straight line. Point A is in contact with the opposite side of the river where the points A and E form a straight line.
It is given that angle $DAE =$ angle $BCF = \theta$, where $0° < \theta < 90°$.



(a) Show that the width of the river is given by $W = 50\sin\theta + 30\cos\theta$. [2]

(b) Express W in the form $R\sin(\theta+\alpha)$, where $R>0$ and $0°<\alpha<90°$. [3]

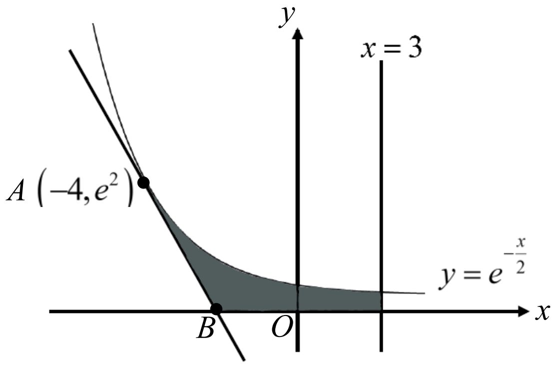
(c) Find the maximum possible value of θ if the cargo ship wishes to pass through a river of width 40 m. [2]

12 **(a)** Sketch the graph of $y = \ln(x-1)$ for $x > 1$. [2]

(b) In order to solve the equation $e^{x-1} = \sqrt{x-1}$, a suitable straight line has to be drawn on the same set of axes as the graph of $y = \ln(x-1)$.

Find the equation of this straight line. [3]

13



The diagram shows part of the curve $y = e^{-\frac{x}{2}}$.

The tangent to the curve at $A\left(-4, e^2\right)$ meets the x-axis at B.

Find the area of the shaded region bounded by the curve, the tangent to the curve at A, the line $x = 3$ and the x – axis. [8]

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