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Write your **student number** in the boxes above.

Letter

Specialist Mathematics Examination 1

Question and Answer Book

VCE (NHT) Examination – Thursday 21 May 2026

- Reading time is **15 minutes**: 10.30 am to 10.45 am
- Writing time is **1 hour**: 10.45 am to 11.45 am

Materials supplied

- Question and Answer Book of 12 pages
- Formula Sheet

Students are **not** permitted to bring any technology (calculators or software) or notes of any kind into the examination room.

Students are **not** permitted to bring mobile phones and/or any unauthorised electronic devices into the examination room.

Contents	pages
11 questions (40 marks)	2–11

Instructions

- Answer **all** questions in the spaces provided.
- Write your responses in English.
- Unless otherwise specified, an **exact** answer is required for each question.
- In questions where more than one mark is available, appropriate working **must** be shown.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- Take the **acceleration due to gravity** to have magnitude $g \text{ m s}^{-2}$, where $g = 9.8$

Question 1 (3 marks)

An object is moving in a straight line with constant positive acceleration.

At time t seconds, its velocity is $v \text{ m s}^{-1}$ and its displacement is d metres.

When $t = 2$, $v = 7$ and $d = 10$.

- a. Show that the initial velocity of the object is 3 m s^{-1} . 1 mark

- b. After how many seconds is the object's displacement 28 m? 2 marks

Do not write in this area.

Question 4 (4 marks)

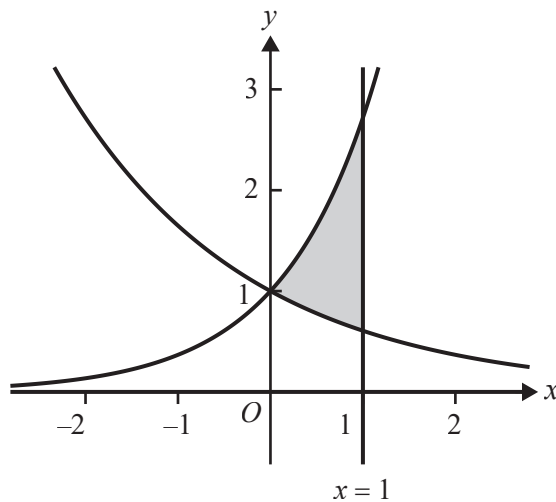
a. Consider the differential equation $2 \frac{d^2y}{dx^2} - \frac{dy}{dx} - y = 0$.

Two solutions of the differential equation have the form $y = e^{mx}$, where $m \in R$.

Show that $m = -\frac{1}{2}$ or $m = 1$.

2 marks

b. The graphs of the two solutions of the differential equation are shown on the Cartesian plane below.



The shaded region shown above is bounded by the two curves and the line with equation $x = 1$. This region is rotated about the x -axis to form a solid of revolution.

Calculate the volume of this solid.

2 marks

Question 5 (4 marks)

Evaluate $\int_0^3 \frac{x^2 + 2x}{\sqrt{x+1}} dx$.

Question 6 (3 marks)

The masses of a particular variety of cherry tomato may be assumed to be normally distributed with a population standard deviation of 6 grams. A sample of size n is randomly selected from a large population of cherry tomatoes and an approximate 90% confidence interval for the population mean of the masses is calculated to be (11.51, 18.09).

Use $\Pr(Z < 1.645) = 0.95$ in your calculations.

- a.** Write down the sample mean.

1 mark

- b.** Calculate n , the sample size.

2 marks

Question 7 (3 marks)

A curve is described by the parametric equations $x = t^2 + \frac{1}{t^2}$ and $y = t^2 - \frac{1}{t^2}$, where $t \in \mathbb{R} \setminus \{0\}$.

- a.** Find the coordinates of any points on the curve that have a vertical tangent. 2 marks

- b.** Find the Cartesian equation of the curve. 1 mark

Question 8 (3 marks)

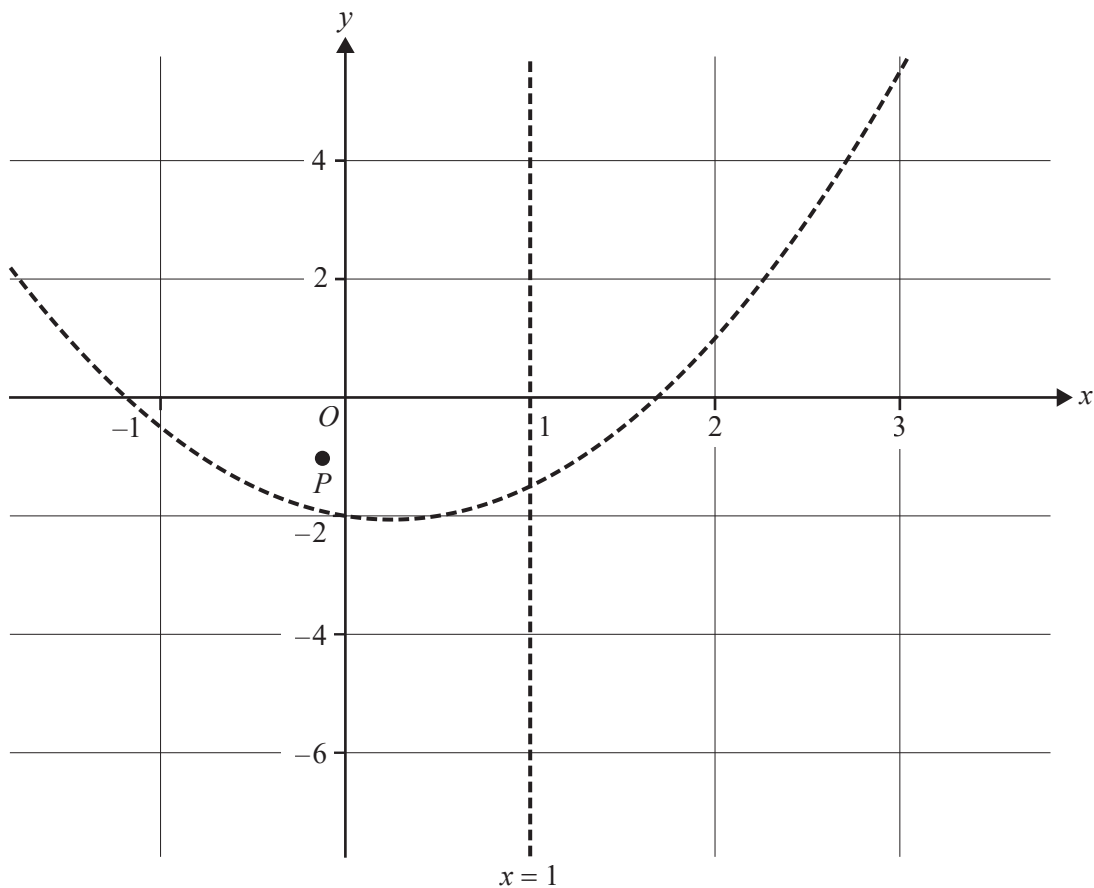
Given that $f'(x) = 4x^3 \log_e(2x)$ and $f\left(\frac{1}{2}\right) = 0$, find $f(x)$.

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Question 9 (6 marks)

The asymptotes of the graph of $f(x) = \frac{2x^3 - 3x^2 - 3x + 2}{2x - 2}$ are shown below.



a. Find the equation of the parabolic asymptote.

2 marks

b. Find the x -intercepts of the graph of $f(x)$.

2 marks

c. Given that there is a turning point, P , at approximately $(-0.14, -1.03)$ as shown, sketch the graph of $y = f(x)$ on the axes provided on page 8, labelling the y -intercept.

2 marks



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Specialist Mathematics Examination 1

2026 Formula Sheet

You may keep this Formula Sheet.

Mensuration

area of a circle segment	$\frac{r^2}{2}(\theta - \sin(\theta))$	volume of a sphere	$\frac{4}{3}\pi r^3$
volume of a cylinder	$\pi r^2 h$	area of a triangle	$\frac{1}{2}bc \sin(A)$
volume of a cone	$\frac{1}{3}\pi r^2 h$	sine rule	$\frac{a}{\sin(A)} = \frac{b}{\sin(B)} = \frac{c}{\sin(C)}$
volume of a pyramid	$\frac{1}{3}Ah$	cosine rule	$c^2 = a^2 + b^2 - 2ab \cos(C)$

Algebra, number and structure (complex numbers)

$z = x + iy = r(\cos(\theta) + i \sin(\theta)) = r \operatorname{cis}(\theta)$	$ z = \sqrt{x^2 + y^2} = r$	
$-\pi < \operatorname{Arg}(z) \leq \pi$	$z_1 z_2 = r_1 r_2 \operatorname{cis}(\theta_1 + \theta_2)$	
$\frac{z_1}{z_2} = \frac{r_1}{r_2} \operatorname{cis}(\theta_1 - \theta_2)$	de Moivre's theorem	$z^n = r^n \operatorname{cis}(n\theta)$

Data analysis, probability and statistics

for independent random variables X_1, X_2, \dots, X_n	$E(aX_1 + b) = a E(X_1) + b$ $E(a_1X_1 + a_2X_2 + \dots + a_nX_n)$ $= a_1E(X_1) + a_2E(X_2) + \dots + a_nE(X_n)$	
	$\text{Var}(aX_1 + b) = a^2\text{Var}(X_1)$ $\text{Var}(a_1X_1 + a_2X_2 + \dots + a_nX_n)$ $= a_1^2\text{Var}(X_1) + a_2^2\text{Var}(X_2) + \dots + a_n^2\text{Var}(X_n)$	
for independent identically distributed variables X_1, X_2, \dots, X_n	$E(X_1 + X_2 + \dots + X_n) = n\mu$	
	$\text{Var}(X_1 + X_2 + \dots + X_n) = n\sigma^2$	
approximate confidence interval for μ	$\left(\bar{x} - z \frac{s}{\sqrt{n}}, \bar{x} + z \frac{s}{\sqrt{n}} \right)$	
distribution of sample mean \bar{X}	mean	$E(\bar{X}) = \mu$
	variance	$\text{Var}(\bar{X}) = \frac{\sigma^2}{n}$

Calculus

$\frac{d}{dx}(x^n) = nx^{n-1}$	$\int x^n dx = \frac{1}{n+1}x^{n+1} + c, n \neq -1$
$\frac{d}{dx}(e^{ax}) = ae^{ax}$	$\int e^{ax} dx = \frac{1}{a}e^{ax} + c$
$\frac{d}{dx}(\log_e(x)) = \frac{1}{x}$	$\int \frac{1}{x} dx = \log_e x + c$
$\frac{d}{dx}(\sin(ax)) = a \cos(ax)$	$\int \sin(ax) dx = -\frac{1}{a} \cos(ax) + c$
$\frac{d}{dx}(\cos(ax)) = -a \sin(ax)$	$\int \cos(ax) dx = \frac{1}{a} \sin(ax) + c$
$\frac{d}{dx}(\tan(ax)) = a \sec^2(ax)$	$\int \sec^2(ax) dx = \frac{1}{a} \tan(ax) + c$
$\frac{d}{dx}(\cot(ax)) = -a \operatorname{cosec}^2(ax)$	$\int \operatorname{cosec}^2(ax) dx = -\frac{1}{a} \cot(ax) + c$
$\frac{d}{dx}(\sec(ax)) = a \sec(ax) \tan(ax)$	$\int \sec(ax) \tan(ax) dx = \frac{1}{a} \sec(ax) + c$
$\frac{d}{dx}(\operatorname{cosec}(ax)) = -a \operatorname{cosec}(ax) \cot(ax)$	$\int \operatorname{cosec}(ax) \cot(ax) dx = -\frac{1}{a} \operatorname{cosec}(ax) + c$
$\frac{d}{dx}(\sin^{-1}(ax)) = \frac{a}{\sqrt{1-(ax)^2}}$	$\int \frac{1}{\sqrt{a^2-x^2}} dx = \sin^{-1}\left(\frac{x}{a}\right) + c, a > 0$
$\frac{d}{dx}(\cos^{-1}(ax)) = \frac{-a}{\sqrt{1-(ax)^2}}$	$\int \frac{-1}{\sqrt{a^2-x^2}} dx = \cos^{-1}\left(\frac{x}{a}\right) + c, a > 0$
$\frac{d}{dx}(\tan^{-1}(ax)) = \frac{a}{1+(ax)^2}$	$\int \frac{a}{a^2+x^2} dx = \tan^{-1}\left(\frac{x}{a}\right) + c$
	$\int (ax+b)^n dx = \frac{1}{a(n+1)}(ax+b)^{n+1} + c, n \neq -1$
	$\int \frac{1}{ax+b} dx = \frac{1}{a} \log_e ax+b + c$

Calculus – continued

product rule	$\frac{d}{dx}(uv) = u \frac{dv}{dx} + v \frac{du}{dx}$
quotient rule	$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2}$
chain rule	$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$
integration by parts	$\int u \frac{dv}{dx} dx = uv - \int v \frac{du}{dx} dx$
Euler's method	<p>If $\frac{dy}{dx} = f(x, y)$, $x_0 = a$ and $y_0 = b$,</p> <p>then $x_{n+1} = x_n + h$ and</p> $y_{n+1} = y_n + h \times f(x_n, y_n)$
arc length parametric	$\int_{t_1}^{t_2} \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2} dt$
surface area Cartesian about x -axis	$\int_{x_1}^{x_2} 2\pi y \sqrt{1 + \left(\frac{dy}{dx}\right)^2} dx$
surface area Cartesian about y -axis	$\int_{y_1}^{y_2} 2\pi x \sqrt{1 + \left(\frac{dx}{dy}\right)^2} dy$
surface area parametric about x -axis	$\int_{t_1}^{t_2} 2\pi y \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2} dt$
surface area parametric about y -axis	$\int_{t_1}^{t_2} 2\pi x \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2} dt$

Kinematics

acceleration	$a = \frac{d^2x}{dt^2} = \frac{dv}{dt} = v \frac{dv}{dx} = \frac{d}{dx} \left(\frac{1}{2} v^2 \right)$	
constant acceleration formulas	$v = u + at$	$s = ut + \frac{1}{2} at^2$
	$v^2 = u^2 + 2as$	$s = \frac{1}{2}(u + v)t$

Vectors in two and three dimensions

$\underline{r}(t) = x(t)\underline{i} + y(t)\underline{j} + z(t)\underline{k}$	$ \underline{r}(t) = \sqrt{x(t)^2 + y(t)^2 + z(t)^2}$
	$\dot{\underline{r}}(t) = \frac{d\underline{r}}{dt} = \frac{dx}{dt}\underline{i} + \frac{dy}{dt}\underline{j} + \frac{dz}{dt}\underline{k}$
for $\underline{r}_1 = x_1\underline{i} + y_1\underline{j} + z_1\underline{k}$ and $\underline{r}_2 = x_2\underline{i} + y_2\underline{j} + z_2\underline{k}$	vector scalar product $\underline{r}_1 \cdot \underline{r}_2 = \underline{r}_1 \underline{r}_2 \cos(\theta) = x_1x_2 + y_1y_2 + z_1z_2$
	vector cross product $\underline{r}_1 \times \underline{r}_2 = \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \end{vmatrix} = (y_1z_2 - y_2z_1)\underline{i} + (x_2z_1 - x_1z_2)\underline{j} + (x_1y_2 - x_2y_1)\underline{k}$
vector equation of a line	$\underline{r}(t) = \underline{r}_1 + t\underline{r}_2 = (x_1 + x_2t)\underline{i} + (y_1 + y_2t)\underline{j} + (z_1 + z_2t)\underline{k}$
parametric equation of a line	$x(t) = x_1 + x_2t \quad y(t) = y_1 + y_2t \quad z(t) = z_1 + z_2t$
vector equation of a plane	$\underline{r}(s, t) = \underline{r}_0 + s\underline{r}_1 + t\underline{r}_2$ $= (x_0 + x_1s + x_2t)\underline{i} + (y_0 + y_1s + y_2t)\underline{j} + (z_0 + z_1s + z_2t)\underline{k}$
parametric equation of a plane	$x(s, t) = x_0 + x_1s + x_2t, \quad y(s, t) = y_0 + y_1s + y_2t, \quad z(s, t) = z_0 + z_1s + z_2t$
Cartesian equation of a plane	$ax + by + cz = d$

Circular functions

$\cos^2(x) + \sin^2(x) = 1$	
$1 + \tan^2(x) = \sec^2(x)$	$\cot^2(x) + 1 = \operatorname{cosec}^2(x)$
$\sin(x + y) = \sin(x) \cos(y) + \cos(x) \sin(y)$	$\sin(x - y) = \sin(x) \cos(y) - \cos(x) \sin(y)$
$\cos(x + y) = \cos(x) \cos(y) - \sin(x) \sin(y)$	$\cos(x - y) = \cos(x) \cos(y) + \sin(x) \sin(y)$
$\tan(x + y) = \frac{\tan(x) + \tan(y)}{1 - \tan(x) \tan(y)}$	$\tan(x - y) = \frac{\tan(x) - \tan(y)}{1 + \tan(x) \tan(y)}$
$\sin(2x) = 2 \sin(x) \cos(x)$	
$\cos(2x) = \cos^2(x) - \sin^2(x) = 2 \cos^2(x) - 1 = 1 - 2 \sin^2(x)$	$\tan(2x) = \frac{2 \tan(x)}{1 - \tan^2(x)}$
$\sin^2(ax) = \frac{1}{2}(1 - \cos(2ax))$	$\cos^2(ax) = \frac{1}{2}(1 + \cos(2ax))$

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