Specialist Mathematics 2025

IA3 sample marking scheme

September 2025

This sample has been compiled by the QCAA to model one possible approach to allocating marks in an examination. It matches the examination mark allocations as specified in the syllabus (~ 60% simple familiar, ~ 20% complex familiar and ~ 20% complex unfamiliar) and ensures that a balance of the objectives are assessed.

Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

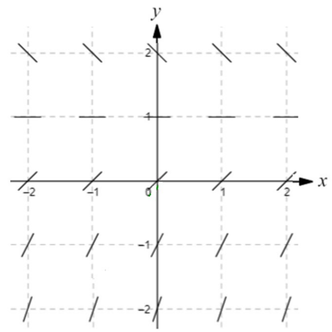
1. Recall mathematical knowledge.
2. Use mathematical knowledge.
3. Communicate mathematical knowledge.
4. Evaluate the reasonableness of solutions.
5. Justify procedures and decisions.
6. Solve mathematical problems.

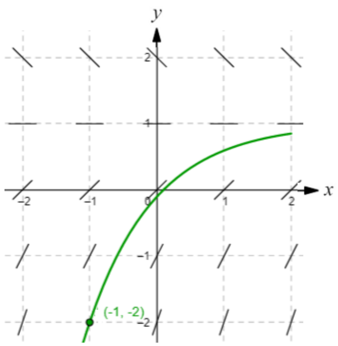
Marking scheme

Short Response: Paper 1 – Technology-free

Q	Sample response	The response	Notes
1	$F(x)=\int 2x e^{x^2+3}\ dx$ Let $u=x^2+3 \Rightarrow \frac{du}{dx}=2x$	• correctly determines a suitable substitution and its derivative **[1 mark]**	Half marks apply. One for correct identification of u and one for correct derivative.
	$\int 2x e^{x^2+3}\ dx=\int e^u\ du$	• expresses integrand in terms of substituted variable **[1 mark]**	Allow FT marks due to error/s in prior working.
	$=e^u+c$ $=e^{x^2+3}+c$	• determines general solution in terms of x **[1 mark]**	

Q	Sample response	The response	Notes
2	$\frac{d}{dx}\left(2x^2+3y^2=14\right)$ $4x+6y\frac{dy}{dx}=0$	• correctly uses implicit differentiation to determine the derivative of the curve **[1 mark]**	Half marks apply. Award for partial correct derivative.
	Substitute $A(1,\ 2)$: $4+12\frac{dy}{dx}=0$	• substitutes for x and y into **[1 mark]**	Allow FT marks due to error/s in prior working.
	$\frac{dy}{dx}=-\frac{4}{12}$ $=-\frac{1}{3}$	• determines gradient at $A(1,\ 2)$ **[1 mark]**	Students may re-arrange and make $\frac{dy}{dx}$ the subject **[1 mark]** and then substitute for x and y **[1 mark]**.

<table>
<tr><th>Q</th><th>Sample response</th><th>The response</th><th>Notes</th></tr>
<tr><td>3a</td><td>Given $\frac{dy}{dx}=1-y$, the completed table values are
<table>
<tr><td>y</td><td>2</td><td>1</td><td>0</td><td>-1</td><td>-2</td></tr>
<tr><td>$\frac{dy}{dx}$</td><td>-1</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
</table></td><td>• correctly completes all values in the table **[1 mark]**</td><td>Half marks apply. One for three correct values.</td></tr>
<tr><td>3b</td><td>
</td><td>• sketches the slope field using the table results for $y=1$ and $y=2$ **[1 mark]**

• sketches the slope field using the table results for $y=0$, $y=-1$ and $y=-2$ **[1 mark]**</td><td>Allow FT marks due to error/s in prior working.</td></tr>
<tr><td>3c</td><td>
</td><td>• sketches a solution curve that passes through $(-1,-2)$ and is asymptotic at the line $y=1$ **[1 mark]**

• sketches a solution curve that has an appropriate basic shape with decreasing positive slopes as x increases **[1 mark]**</td><td></td></tr>
</table>

Q	Sample response	The response	Notes
4	Using $V=\frac{4}{3}\pi r^3$ and given $\frac{dr}{dt}=3$	• correctly selects appropriate volume rule and recognises the value of $\frac{dr}{dt}$ **[1 mark]**	This mark may be implied by subsequent working.
	Using chain rule: $\frac{dV}{dt}=\frac{dV}{dr}\times\frac{dr}{dt}$	• correctly uses the chain rule to determine an expression for $\frac{dV}{dt}$ **[1 mark]**	This mark may be implied by subsequent working.
	$=4\pi r^2\times 3$ $=12\pi r^2$	• determines an expression for $\frac{dV}{dt}$ in terms of r **[1 mark]**	Allow FT marks due to error/s in prior working.
	When $r=5$ $\frac{dV}{dt}=12\pi\left(5^2\right)$ $=300\pi$ cm^3 per minute	• determines the value of $\frac{dV}{dt}$ when $r=5$ including suitable units **[1 mark]**	Half marks apply. Award for $\frac{dV}{dt}$ and suitable units.

Q	Sample response	The response	Notes
5	Shaded area $=\int_1^e 4x\ \ln(x)\ dx$	• correctly determines a definite integral to represent the shaded area **[1 mark]**	
	Using integration by parts to find $\int 4x\ln(x)dx$ Let $u=\ln(x)$ $\quad \frac{dv}{dx}=4x$ $\frac{du}{dx}=\frac{1}{x}$ $\quad v=2x^2$ $\int u\frac{dv}{dx}dx=uv-\int v\frac{du}{dx}dx$	• identifies u and $\frac{dv}{dx}$ **[1 mark]** • determines $\frac{du}{dx}$ and v **[1 mark]**	Allow FT marks for errors in prior working. Half marks apply. One each for $\frac{du}{dx}$ and v.
	Shaded area $=\int_1^e 4x\ \ln(x)\ dx$ $=\left[2x^2\ \ln(x)\right]_1^e-\int_1^e 2x^2\ \frac{1}{x}\ dx$ $=\left[2x^2\ \ln(x)-x^2\right]_1^e$	• determines an expression for the integral **[1 mark]**	
	$=\left(2e^2\ \ln(e)-e^2\right)-\left(2\ln(1)-1^2\right)$	• substitutes upper and lower limits of integration into the expression **[1 mark]**	This mark may be implied by subsequent working.
	$=e^2+1$ units^2	• determines shaded area **[1 mark]**	

Short Response: Paper 2 – Technology-active

Q	Sample response	The response	Notes
6a	$P(5 < X < 10) = \int_5^{10} 0.04\,e^{-0.04x}\,dx$	• correctly determines a definite integral to represent the required probability **[1 mark]**	
	≈ 0.148	• determines the required probability **[1 mark]**	Allow FT marks for errors in prior working. Accept value to any number of decimal places using rounding or truncation.
6b	$P(5 < X < 10 \mid X < 10) = \dfrac{P(5 < X < 10)}{P(X < 10)}$ $= \dfrac{\int_5^{10} 0.04\,e^{-0.04x}\,dx}{\int_0^{10} 0.04\,e^{-0.04x}\,dx}$	• determines an equation to find the conditional probability **[1 mark]**	This mark may be implied by subsequent working.
	≈ 0.45	• determines the conditional probability **[1 mark]**	

Q	Sample response	The response	Notes
7	Given $f(x)=\frac{\ln(x+0.1)}{2.1}-x+7.1$ Using 4 strips for $0 \le x \le 8 \Rightarrow w=2$	• correctly determines strip width **[1 mark]**	
	<table><tr><td>n</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>x_n</td><td>0</td><td>2</td><td>4</td><td>6</td><td>8</td></tr><tr><td>$f(x_n)$</td><td>6.004</td><td>5.453</td><td>3.772</td><td>1.961</td><td>0.096</td></tr></table>	• correctly calculates the five appropriate $f(x)$ values based on strip width **[1 mark]**	This mark may be implied by subsequent working. Evidence of values used is required to be awarded this mark.
	Area $\approx \frac{w}{3}\left[f(x_0)+4\left[f(x_1)+f(x_3)+\ldots\right]+2\left[f(x_2)+f(x_4)+\ldots\right]+f(x_n)\right]$ $\approx \frac{2}{3}\left[6.004+4\left[5.453+1.961\right]+2\left[3.772\right]+0.096\right]$	• substitutes values into Simpson's rule **[1 mark]**	Allow FT marks for errors in prior working. This mark may be implied by subsequent working.
	$= 28.87\ \text{m}^2$	• calculates approximate area **[1 mark]**	Accept value to any number of decimal places using rounding or truncation.

Q	Sample response	The response	Notes
8a	Volume $= \pi \int_a^b [f(x)]^2 \, dx$ $= \pi \int_0^{\frac{\pi}{4}} \cos^2(x) \, dx$	• correctly determines a definite integral to represent the required volume **[1 mark]**	
8b	Volume $= \pi \int_0^{\frac{\pi}{4}} \frac{1}{2}\left(1+\cos(2x)\right) \, dx$	• correctly uses an appropriate trigonometric substitution for $\cos^2(x)$ **[[1 mark]**	
	$= \pi \left[\left(\frac{1}{2}\left(x+\frac{1}{2}\sin(2x)\right)\right)\right]\Big\vert_0^{\frac{\pi}{4}}$	• determines an expression for the integral **[1 mark]**	Allow FT marks due to error/s in prior working.
	$= \frac{\pi}{2}\left[\left(\frac{\pi}{4}+\frac{1}{2}\sin\left(\frac{\pi}{2}\right)\right)-\left(0+\frac{1}{2}\sin(0)\right)\right]$	• substitutes upper and lower limits of integration into the volume expression **[1 mark]**	This mark may be implied by subsequent working.
	$= \frac{\pi}{2}\left(\frac{\pi}{4}+\frac{1}{2}\right)$ units^3	• determines required volume **[1 mark]**	
8c	Using GDC $\pi \int_0^{\frac{\pi}{4}} \cos^2(x) \, dx = 2.0191...$	• uses technology to determine the value of the definite integral **[1 mark]**	Accept value to any number of decimal places using rounding or truncation.
	$\frac{\pi}{2}\left(\frac{\pi}{4}+\frac{1}{2}\right) = 2.0191...$ so the result is verified	• verifies results are the same **[1 mark]**	

Q	Sample response	The response	Notes
9	Given $\frac{dp}{dt}=\sqrt{4-p^2}$ Using separation of variables: $\int \frac{dp}{\sqrt{4-p^2}}=\int dt$	• correctly uses separation of variables for the differential equation **[1 mark]**	The dp and dt terms must be included to be awarded the mark.
	$\sin^{-1}\left(\frac{p}{2}\right)=t+c$	• determines general solution of the differential equation **[1 mark]**	Allow FT marks due to error/s in prior working.
	Given $p=0.5$ when $t=0$ $\sin^{-1}\left(\frac{0.5}{2}\right)=0+c$ $c\approx 0.253$ $\sin^{-1}\left(\frac{p}{2}\right)=t+0.253$	• determines particular solution of the differential equation **[1 mark]**	Accept value to any number of decimal places using rounding or truncation.
	When $t=1$, $\sin^{-1}\left(\frac{p}{2}\right)=1.253$, $p=2\sin(1.253)$ ≈ 1.90	• determines the required value of p **[1 mark]**	

Q	Sample response	The response	Notes
10	Consider the type-B battery: $E(X)=\int_{-\infty}^{\infty} x\,p(x)\,dx$ $E\left(T_B\right)=\int_{0}^{\infty}\frac{1}{9}t^2 e^{-\frac{t}{3}}\,dt$	• correctly determines the equation for finding the expected lifespan of a type-B battery **[1 mark]**	This mark may be implied by subsequent working.
	$=6$ months	• determines the expected lifespan of type-B battery **[1 mark]**	Allow FT marks due to error/s in prior working.
	Consider the type-A battery: $E\left(T_A\right)=\mu=3$ months As the pdf is modelled by an exponential function $\lambda=\frac{1}{\mu}=\frac{1}{3}$	• determines value of λ **[1 mark]**	
	$P(T_A \geq 6)=\int_{6}^{\infty}\frac{1}{3}e^{-\frac{t}{3}}\,dt$ $=0.135$	• determines required probability **[1 mark]**	Accept value to any number of decimal places using rounding or truncation.

Q	Sample response	The response	Notes
11	Gradient is represented as the differential equation $\frac{dy}{dx}=\left(y^2-11y+30\right)\sec^2(x)$ Using separation of variables: $\int\frac{dy}{y^2-11y+30}=\int\sec^2(x)\,dx$	• correctly uses separation of variables for the generated differential equation **[1 mark]**	The dy and dx terms must be included to be awarded the mark.
	$\int\frac{dy}{(y-5)(y-6)}=\int\sec^2(x)$ ...(1) Using partial fractions procedure for the LHS integrand: $\int\frac{1}{(y-5)(y-6)}=\frac{A}{y-5}+\frac{B}{y-6}$ $1=A(y-6)+B(y-5)$ $y=5\Rightarrow A=-1$ and $y=6\Rightarrow B=1$ $\int\frac{dy}{(y-5)(y-6)}=\int\frac{-1}{y-5}+\frac{1}{y-6}\,dy$ $=-\ln(y-5)+\ln(y-6)+c$	• determines the integral of $\frac{1}{y^2-11y+30}$ in terms of y **[1 mark]**	Allow FT mark due to error/s in prior working. This mark may be implied by subsequent working.
	$\int\sec^2(x)\,dx=\tan(x)+c$	• correctly determines the integral of $\sec^2(x)$ in terms of x **[1 mark]**	This mark may be implied by subsequent working.
	From (1), $\ln\left\|\frac{y-6}{y-5}\right\|=\tan(x)+c$ Given $x=0, y=4\Rightarrow\ln(2)=c$ $\ln\left\|\frac{y-6}{y-5}\right\|=\tan(x)-\ln(2)$	• determines the particular solution of the differential equation **[1 mark]**	Allow FT marks due to error/s in prior working. Accept equivalent solution.

Q	Sample response	The response	Notes
	When $f(a)=a$, the *x*- and *y*-coordinates are equal $\ln\left\|\frac{a-6}{a-5}\right\|=\tan(a)-\ln(2)$	• determines an equation in terms of *a* **[1 mark]**	Accept equivalent equation.
	Using GDC $a \approx -0.484$ is the only solution in the given domain.	• determines the only value of *a* **[1 mark]**	Accept value to any number of decimal places using rounding or truncation.