Mathematical Methods 2025 v1.3

IA3: sample marking scheme

March 2026

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
1a	Population proportion $p=\frac{12}{100}$	• correctly determines the population proportion **[1 mark]**	Accept equivalent form, e.g. $\frac{3}{25}$, 0.12, 12%.
1b	Sample proportion $\hat{p}=\frac{4}{20}$	• correctly determines the sample proportion **[1 mark]**	Accept equivalent form, e.g. $\frac{1}{5}$, 0.2, 20%.
2a	$P(20 \le X \le 30)=\frac{8}{25}$	• correctly chooses the class interval **[0.5 marks]** • estimates the probability **[0.5 marks]**	Accept equivalent form, e.g. $\frac{32}{100}$, 0.32, 32%.
2b	$P(X \ge 30)=\frac{7+4+3}{25}$	• correctly identifies categories and their relative frequencies **[1 mark]**	
	$P(X \ge 30)=\frac{14}{25}$	• estimates the probability **[1 mark]**	Allow FT mark due to error/s in prior working. Accept equivalent form, e.g. $\frac{56}{100}$, 0.56, 56%.

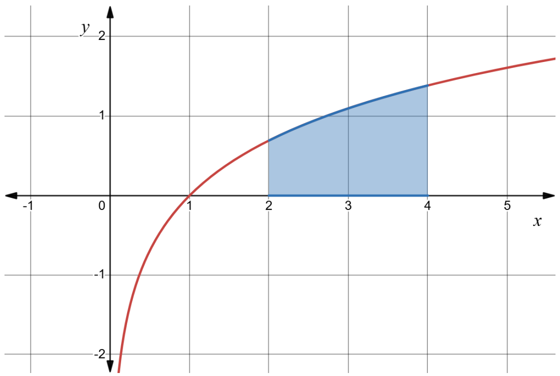
Q	Sample response	The response	Notes
3a	$\int_1^4 6\sqrt{x}\,dx$ $=\left[4x^{\frac{3}{2}}\right]_1^4$	• correctly determines an expression for the integral **[1 mark]**	This mark may be implied by subsequent working.
	$=4\times4^{\frac{3}{2}}-4\times1^{\frac{3}{2}}$	• substitutes upper and lower limits of integration into the expression **[0.5 marks]**	Allow FT mark due to error/s in prior working
	$=28$	• determines the value of the definite integral **[0.5 marks]**	
3b	$\int_1^3 e^{2x}-\frac{1}{x}\,dx$ $=\left[\frac{e^{2x}}{2}-\ln x\right]_1^3$	• correctly determines an expression for the integral **[1 mark]**	This mark may be implied by subsequent working.
	$=\left(\frac{e^6}{2}-\ln 3\right)-\left(\frac{e^2}{2}-\ln 1\right)$	• substitutes upper and lower limits of integration into the expression **[0.5 marks]**	Allow FT marks due to error/s in prior working.
	$=\frac{e^6-e^2}{2}-\ln 3$	• determines the value of the definite integral **[0.5 marks]**	Accept equivalent form, e.g. $\frac{1}{2}(e^6-e^2)-\ln(3\times1)$.

Q	Sample response	The response	Notes
4	Finding x intercepts $6x-3x^2=0$	• identifies need for x intercepts **[0.5 marks]**	
	$3x(2-x)=0$ $x=0$ or $x=2$	• correctly determines x intercepts **[0.5 marks]**	
	Area $=\int_0^2 6x-3x^2\ dx$	• correctly determines a definite integral to represent the area **[0.5 marks]**	
	$=\left[3x^2-x^3\right]_0^2$	• determines an expression for the area **[1 mark]**	Allow FT marks due to error/s in prior working.
	$=\left(3\times2^2-2^3\right)-\left(3\times0^2-0^3\right)$ $=4$ units^2	• evaluates the area **[0.5 marks]**	

Q	Sample response	The response	Notes
5	$\int_0^2 kx\,dx = 1$	• correctly identifies the PDF condition **[0.5 marks]**	
	$\left[\frac{kx^2}{2}\right]_0^2 = 1$ $k = \frac{1}{2}$	• determines the value of k **[0.5 marks]**	Allow FT mark due to error/s in prior working
	$E(X) = \mu = \int_{-\infty}^{\infty} x\ p(x)\,dx$	• correctly identifies the rule for $E(X)$ **[0.5 marks]**	Accept equivalent rule, e.g. $Var(X) = E(X^2) - E(X)^2$
	$E(X) = \int_0^2 \frac{1}{2}x^2\,dx$ $= \left[\frac{1}{6}x^3\right]_0^2$ $= \frac{4}{3}$	• determines $E(X)$ **[1 mark]**	Allow FT mark due to error/s in prior working
	$Var(X) = \int_{-\infty}^{\infty} (x-\mu)^2\ p(x)\,dx$	• correctly identifies the rule for $Var(X)$ **[0.5 marks]**	
	$Var(X) = \int_0^2 \left(x - \frac{4}{3}\right)^2 \times \frac{1}{2}x\,dx$ $= \left[\frac{1}{2}\left(\frac{1}{4}x^4 - \frac{8}{9}x^3 + \frac{8}{9}x^3\right)\right]_0^2$ $= \frac{1}{2}\left(\frac{1}{4}\times 2^4 - \frac{8}{9}\times 2^3 + \frac{8}{9}\times 2^3\right) - 0$ $= \frac{2}{9}$	• determines $Var(X)$ **[1 mark]**	Allow FT mark due to error/s in prior working

Q	Sample response	The response	Notes
6	Finding intercepts $x^n = \sqrt{x}$ $x = 0$ or $x = 1$	• correctly determines the boundaries of the area **[1 mark]**	
	Smaller leaf $\text{Area} = \int_0^1 \sqrt{x} - x^n \, dx = \frac{7}{15}$	• establishes the equation for the area of the original image **[0.5 marks]**	Allow FT marks due to error/s in prior working
	$\left[\frac{2}{3}x^{\frac{3}{2}} - \frac{x^{n+1}}{n+1}\right]_0^1 = \frac{7}{15}$ $\frac{2}{3} - \frac{1}{n+1} = \frac{7}{15}$ $n = 4$	• determines the value of n **[1 mark]**	
	Larger leaf $\text{Area} = \int_0^1 k\sqrt{x} - kx^{4+1} \, dx = 2$	• establishes the equation for the area of the new image **[0.5 marks]**	
	$k\left[\frac{2}{3}x^{\frac{3}{2}} - \frac{x^6}{6}\right]_0^1 = 2$ $k\left(\frac{2}{3} - \frac{1}{6}\right) = 2$ $k = 4$	• determines the value of k **[0.5 marks]**	
	The functions for the larger leaf are: $f_1(x) = 4\sqrt{x}$ and $f_2(x) = 4x^5$	• communicates the two functions used **[0.5 marks]**	

Short Response: Paper 2 — Technology-active

Q	Sample response	The response	Notes
7a		• correctly sketches a general shape of the function **[0.5 marks]**	This mark can only be awarded if a general shape is correct; graph does not cross the y-axis and the x-intercept is 1.
		• correctly shades the implied area **[0.5 marks]**	This mark can only be awarded if points $x = 2$ and $x = 4$ are indicated on the x-axis and the shaded area is between them.
7b	$Area \approx$ $\frac{w}{2}\left[f(x_0)+2\left(f(x_1)+f(x_2)+...+f(x_{n-1})\right)+f(x_n)\right]$ $w=\frac{4-2}{4}=\frac{1}{2}$	• correctly determines w **[0.5 marks]**	This mark may be implied by subsequent working.
	$Area \approx \frac{1}{4}\left[\ln(2)+2\left(\ln(2.5)+\ln(3)+\ln(3.5)\right)+\ln(4)\right]$	• substitutes values into rule **[0.5 marks]**	Allow FT marks due to error/s in prior working.
	$Area = 2.154$	• determines the approximate area **[0.5 marks]**	
7c	$\int_2^4 \ln(x)\, dx = 2.159$	• correctly determines the area using the definite integrate on calculator **[1 mark]**	
	The approximate area is close to the value given for the definite integral using the calculator.	• evaluates the reasonableness of the approximate area **[0.5 marks]**	Allow FT mark due to error/s in prior working.

Q	Sample response	The response	Notes
8a	Billie could randomly select ID numbers to choose the students for the sample.	• describes method to avoid bias **[1 mark]**	Accept any other appropriate alternative response.
8b	Using technology $p = 0.8$	• correctly determines mean **[1 mark]**	
8c	$\text{standard deviation} = \sqrt{\frac{p(1-p)}{n}}$ $0.05 = \sqrt{\frac{0.8(1-0.8)}{n}}$	• correctly substitutes into formula for standard deviation **[1 mark]**	This mark may be implied by subsequent working.
	Using technology $n = 64$	• determines n **[1 mark]**	Allow FT mark due to error/s in prior working.
8d	$\frac{\hat{p}-p}{\sqrt{\hat{p}(1-\hat{p})/n}}$ $= \frac{0.845-0.8}{\sqrt{0.845(1-0.845)/64}}$ $= 0.995$	• determines the missing score **[1 mark]**	Accept answer to any number of decimal places.
8e	$\frac{6}{10} = 60\%$	• determines the percentage **[1 mark]**	

Q	Sample response	The response	Notes
9ai	change in first 5 months $= \int_0^5 50\sin\left(\frac{\pi t}{20}\right) dt$	• correctly determines an expression for the change in population **[0.5 marks]**	
	$= 93.231$	• determines the change during the first 5 months **[1 mark]**	Allow FT mark due to error/s in prior working.
9aii	change in last 5 months $= \int_5^{10} 50\sin\left(\frac{\pi t}{20}\right) dt$	• correctly determines an expression for the change in population **[0.5 marks]**	
	$= 225.079$	• determines the change during the last 5 months **[1 mark]**	Allow FT marks due to error/s in prior working.
9b	The population is increasing as it grew by 93 ants during the first 5 months, and by 225 ants for the later 5-month period.	• Compares the change in population during the given periods **[1 mark]**	Accept any appropriate alternative answer.

Q	Sample response	The response	Notes
10a	$\mu = 50, \sigma = 6$	• correctly identifies parameters **[0.5 marks]**	
	Using technology $P(X \leq 42) = 0.091$	• determines the probability **[1 mark]**	Allow FT marks due to error/s in prior working.
10b	Using technology $P(45 \leq X \leq 53) = 0.489$	• determines the probability **[1 mark]**	
10c		• correctly identifies probability region given **[0.5 marks]**	This mark may be implied by subsequent working. Accept alternative representation.
	Using technology $a = 53.497 \approx 53.5$	• determines the value of a **[1 mark]**	Allow FT mark due to error/s in prior working. Accept answer to any number of decimal places.

Q	Sample response	The response	Notes
11	Phase A $n = 30,\ p = 0.22$	• correctly identifies n and p **[0.5 marks]**	This mark may be implied by subsequent working.
	$SD = \sqrt{\frac{p(1-p)}{n}}$ $= \sqrt{\frac{0.22 \times 0.78}{30}}$	• correctly use the rule for standard deviation of sample proportion **[0.5 marks]**	
	$= 0.076$	• determines the value of SD **[1 mark]**	Allow FT mark due to error/s in prior working.
	Phase B $SD = 0.076 - 0.01$ $= 0.066$	• correctly determines the value of SD for Phase B **[0.5 marks]**	
	$0.066 = \sqrt{\frac{0.22 \times 0.78}{n}}$ $n = 39.39 \approx 40$	• determines the value of n for phase B **[1 mark]**	Allow FT mark due to error/s in prior working. Accept n = 39
	$P(X < 8) \Rightarrow P\left(\hat{p} < \frac{8}{40}\right)$	• correctly determines value of $\hat{p}$ **[0.5 marks]**	These marks may be implied by subsequent working. Allow alternative result due to n = 39
	$\mu = 0.22$	• correctly identifies μ **[0.5 marks]**	
	$\sigma = 0.066$	• correctly identifies σ **[0.5 marks]**	
	Using technology $P\left(\hat{p} < \frac{8}{40}\right) = 0.381$	• determines the probability **[1 mark]**	Allow FT mark due to error/s in prior working.

Q	Sample response	The response	Notes
12	METHOD 1 Finding a $\int_0^{100} ax^2(100-x)\,dx = 1$	• correctly identifies the PDF condition **[0.5 marks]**	This mark may be implied by subsequent working.
	$a = 1.2\times10^{-7}$	• correctly determines a **[0.5 marks]**	
	Finding the probability a student passed the exam $P(X>50) = \int_{50}^{100} 1.2\times10^{-7} x^2(100-x)\,dx$	• correctly identifies conditions to pass the exam **[0.5 marks]**	This mark may be implied by subsequent working.
	$P(X>50) = 0.6875$	• determines the probability of passing the exam **[0.5 marks]**	Allow FT marks due to error/s in prior working.
	Finding the percentage of students who received an A grade $\mathrm{P}(X>M) = \frac{1}{3}\times0.6875 \approx 0.229$	• determines the probability of receiving an A grade **[1 mark]**	This mark may be implied by subsequent working.
	$\mathrm{P}(X>m) = \int_m^{100} 1.2\times10^{-7} x^2(100-x)dx = 0.229$	• determines a valid equation for the cut-off mark for an A grade **[1 mark]**	
	Using technology $m = 76.967$	• determines m **[1 mark]**	This mark may be implied by subsequent working.
	Cut-off mark for A is 77	• interprets m in the context of the question **[1 mark]**	

Q	Sample response	The response	Notes
12	METHOD 2 $\frac{P(\text{receiving } A)}{P(\text{passing the exam})}=\frac{1}{3}$	• correctly identifies conditional probability **[1 mark]**	
	Probability of receiving an A grade: $\int_m^{100} ax^2(100-x)\,dx$	• correctly models *m* the cut-off mark for an A grade **[1 mark]**	This mark may be implied by subsequent working.
	Probability of passing the exam: $\int_{50}^{100} ax^2(100-x)\,dx$	• correctly models the probability of passing the exam **[1 mark]**	This mark may be implied by subsequent working.
	$\frac{\int_m^{100} x^2(100-x)\,dx}{\int_{50}^{100} x^2(100-x)\,dx}=\frac{1}{3}$	• determines an equation for *m* without *a* **[1 mark]**	Allow FT marks due to error/s in prior working.
	Using technology $3\int_m^{100} x^2(100-x)\,dx=\int_{50}^{100} x^2(100-x)\,dx$ $m=76.957$	• determines *m* **[1 mark]**	
	Cut-off mark for A is 77	• interprets *m* in the context of the question **[1 mark]**	