Question	Scheme	Marks	AOs
2 (a)	$\cos^2\frac{x}{3}=\left(1-\frac{\left(\frac{x}{3}\right)^2}{2}+\frac{\left(\frac{x}{3}\right)^4}{24}-...\right)^2=...$ or $\left(1-\frac{x^2}{18}+\frac{x^4}{1944}-...\right)^2=...$ or $\frac{1}{2}\left(1\pm\cos\frac{2x}{3}\right)=\frac{1}{2}\left(1\pm\left(1-\frac{1}{2}\left(\frac{2x}{3}\right)^2+\frac{1}{4!}\left(\frac{2x}{3}\right)^4-\right)...\right)$	M1	2.2a
	$=1-\frac{x^2}{9}+\frac{1}{243}x^4$	A1	1.1b
		(2)	
(b)	$\int\frac{1-\frac{x^2}{9}+\frac{1}{243}x^4}{x}=\int\frac{1}{x}-\frac{x}{9}+\frac{1}{243}x^3=A\ln x+Bx^2+Cx^4$ where A, B and $C\neq 0$	M1	3.1a
	$\ln x-\frac{x^2}{18}+\frac{1}{972}x^4$	A1ft	1.1b
	= awrt 0.98295	A1	2.2a
		(3)	
(c)	Calculator = awrt 0.98280	B1	1.1b
		(1)	
(d)	E.g. the approximation is correct to 3 d.p.	B1	3.2b
		(1)	
			(7 marks)

Notes:

(a)

M1: Deduces the required series by using the Maclaurin series for cos x, replacing x with $\frac{x}{3}$ and squares, or first applying the double angle identity (allow sign error) and then applying the series for cos x with $\frac{2x}{3}$. Attempts at finding from differentiation score M0 as the cosine series is required.

A1: Correct series

(b)

M1: Divides their series in part (a) by x and integrates to the form $A\ln x+Bx^2+Cx^4$

A1ft: Correct integration, follow through on their coefficients and need not be simplified.

A1: Deduces the definite integral awrt 0.98295

(c)

B1: Correct value.

(d)

B1: Makes a quantitative statement about the accuracy, so e.g. how many decimal places or significant figures it is correct to, or calculates a percentage accuracy to deduce it is reasonable. Do not accept just “underestimate” or similar without quantitative evidence. Allow for a reasonable comment as long as (b) is correct to at least 2 s.f. but (c) must be the correct value.