C3 Simpsons Rule Answers

Specimen

2. Integral $\approx \frac{0 \cdot 25}{3}$ [1·41421356 + 4·12310563 + 2(2·46221445) +4 (1·85510275 + 3·22163099)]

M1 (formula with $h = 0{\cdot}25$)

B1 (3 values)

B1 (2 other values)

$\approx$ 2·56

A1 (C.A.O.)

2005 Summer

1. $h = 0.25$

$$\text{Integral} \approx \frac{0.25}{3}\left[1 + 1.4142136 + 4(1.0004882 + 1.1123420) + 2 \times 1.0155049\right]$$

M1 (formula with $h = 0.25$)
B1 (3 values)
B1 (2 values)

$\approx$ 1.075
(accept any answers rounding to 1.075)

A1

[4]

2006 Winter

1. *(a)* $h = 0.25$

Integral $\approx \frac{0.25}{3}$ [1.7320508 + 4.2426407 + 4(2.1074644 + 3.3732634) + 2(2.6575365]

M1 (h= 0.25 use of correct formula)

B1 (3 values)

B1 (2 further values)

$\approx$ 2.768

A1 (F.T. one slip)

4

2006 Summer

1. $h = 0{\cdot}25$ — M1 ($h = 0{\cdot}25$ correct formula)

$$\text{Integral} \approx \frac{0.25}{3}\,[0 + 0{\cdot}8325546 + 4(0{\cdot}4723807 + 0{\cdot}7480747)$$ — B1 (3 values)

$$+ 2(0{\cdot}6367614)]$$ — B1 (2 values)

$$\approx 0{\cdot}582$$ — A1 (F.T. one slip)

4

2007 Winter

1. *(a)* $h = 0{\cdot}2$ — M1 (correct formula $h = 0.2$)

$$\text{Integral} \approx \frac{0{\cdot}2}{3}\,[0{\cdot}69314718 + 1{\cdot}44456327$$

$$+ 4\,(0{\cdot}89199804 + 1{\cdot}26976055)$$ — B1 (3 values)

$$+ 2(1{\cdot}08518927)]$$ — B1 (2 values)

$$= 0{\cdot}864$$ — A1 (F.T. one slip)

(b) Second integral $\approx 0{\cdot}432$ — B1 (F.T. answer in *(a)*)

5

2007 Summer

1. $h = 0{\cdot}1$ — M1 ($h = 0{\cdot}1$ correct formula

$$\text{Integral} \approx \frac{0{\cdot}1}{3}\,[0{\cdot}5 + 0{\cdot}4279957 + 4(0{\cdot}4772563 + 0{\cdot}4420154)$$ — B1 (3 values)

$$+ 2(0{\cdot}4582276)]$$ — B1 (2 values)

$$\approx 0{\cdot}184$$ — A1 (F.T. one slip)

4

2008 Winter

1. $h = 0{\cdot}2$ — M1 (Correct formula $h = 0.2$)

$$\text{Integral} \approx \frac{0{\cdot}2}{3}\,[1 + 1{\cdot}8964809 + 4\,(1{\cdot}0408108 + 1{\cdot}4333294) + 2\,(1{\cdot}1735109)]$$

B1 (3 correct values)
B1 (2 correct values)

$\approx 1{\cdot}0093$ — A1 (F.T. one slip)

(4)

2008 Summer

1. $h = 0{\cdot}25$ — M1 ($h = 0{\cdot}25$, correct formula)

$$\text{Integral} \approx \frac{0.25}{3}\,[0{\cdot}4142136 + 1{\cdot}9282847 + 4\,(1{\cdot}5112992 + 1{\cdot}7655028) + 2(1{\cdot}6274893)]$$

B1 (3 correct values)
B1 (2 correct values)

$\approx 1{\cdot}642$ — A1 (F.T. one slip)

4

2009 Winter

1. $h = \dfrac{2\pi}{\frac{9}{4}} = \dfrac{\pi}{18}$ — M1 (correct formula with $h = \pi/18$)

$$\text{Integral} = \frac{\pi}{3 \times 18}\,[0 + (-0.26651509) + 4\,(-0.01530883 - 0.14384104) + 2(-0.06220246)]$$

B1 (3 values)
B1 (other 2 values)

≈ -0.0598 — A1 (F.T. one slip)

$\int_0^{\frac{2\pi}{9}} \ln(\cos^2 x)\,dx \approx 2\,(-0.0598) = -0.1196$ — B1

(5)

2009 Summer

1. $h = 0{\cdot}2$ ($h = 0{\cdot}2$, correct formula) M1

$$\text{Integral} \approx \frac{0{\cdot}2}{3}[3 + 3{\cdot}7191397 + 4(3{\cdot}1189742 + 3{\cdot}4779304) + 2(3{\cdot}2778041)]$$

(3 values) B1
(2 values) B1

$\approx 2{\cdot}6442$ A1

[Special case: B1 for 6 correct values, at least 5 decimal places:
3, 3·09206, 3·20936, 3·35287, 3·52292, 3·71914]

2010 Winter

1.

0	0·69314718
0·25	0·825939419
0·5	0·974076984
0·75	1·136871006
1	1·313261688

(5 values correct) B2
(3 or 4 values correct) B1

Correct formula with $h = 0{\cdot}25$ M1

$$I \approx \frac{0{\cdot}25}{3} \times \{0{\cdot}69314718 + 1{\cdot}313261688 + 4(0{\cdot}825939419 + 1{\cdot}136871006) + 2(0{\cdot}974076984)\}$$

$I \approx 11{\cdot}80580453 \div 12$
$I \approx 0{\cdot}983817044$
$I \approx 0{\cdot}984$ (f.t. one slip) A1

2010 Summer

1.

0	0·5		
0·2	0·401312339		
0·4	0·310025518		
0·6	0·231475216	(3 values correct)	B1
0·8	0·167981614	(5 values correct)	B1

Correct formula with $h = 0{\cdot}2$ M1

$$I \approx \frac{0{\cdot}2}{3} \times \{0{\cdot}5 + 0{\cdot}167981614 + 4(0{\cdot}401312339 + 0{\cdot}231475216) + 2(0{\cdot}310025518)\}$$

$I \approx 0{\cdot}2 \times 3{\cdot}819182871 \div 3$

$I \approx 0{\cdot}254612191$

$I \approx 0{\cdot}2546$ (f.t. one slip) A1

Note: Answer only with no working earns 0 marks

2011 Winter

1.

4	1		
4·5	1·138071187		
5	1·309016994		
5·5	1·527202251	(5 values correct)	B2
6	1·816496581	(3 or 4 values correct)	B1

Correct formula with $h = 0{\cdot}5$ M1

$$I \approx \frac{0{\cdot}5}{3} \times \{1 + 1{\cdot}816496581 + 4(1{\cdot}138071187 + 1{\cdot}527202251) + 2(1{\cdot}309016994)\}$$

$I \approx 16{\cdot}09562432 \times 0{\cdot}5 \div 3$

$I \approx 2{\cdot}682604054$

$I \approx 2{\cdot}683$ (f.t. one slip) A1

Note: Answer only with no working earns 0 marks

2011 Summer

1. (*a*)

1	1·386294361		
1·25	1·517870719		
1·5	1·658228077		
1·75	1·802122256	(5 values correct)	B2
2	1·945910149	(3 or 4 values correct)	B1

Correct formula with $h = 0{\cdot}25$ M1

$I \approx \frac{0{\cdot}25}{3} \times \{1{\cdot}386294361 + 1{\cdot}945910149 + 4(1{\cdot}517870719 + 1{\cdot}802122256) + 2(1{\cdot}658228077)\}$

$I \approx 19{\cdot}92863256 \div 12$

$I \approx 1{\cdot}66071938$

$I \approx 1{\cdot}6607$ (f.t. one slip) A1

Note: Answer only with no working earns 0 marks

(*b*)

$\int_1^2 \ln\left[\frac{1}{3+x^2}\right] dx \approx -1{\cdot}6607$ (f.t. candidate's answer to (*a*)) B1

2012 Winter

1. (*a*)

0	1		
$\pi/12$	0·933012701		
$\pi/6$	0·75		
$\pi/4$	0·5	(5 values correct)	B2
$\pi/3$	0·25	(3 or 4 values correct)	B1

Correct formula with $h = \pi/12$ M1

$I \approx \frac{\pi/12}{3} \times \{1 + 0{\cdot}25 + 4(0{\cdot}933012701 + 0{\cdot}5) + 2(0{\cdot}75)\}$

$I \approx 8{\cdot}482050804 \times (\pi/12) \div 3$

$I \approx 0{\cdot}740198569$

$I \approx 0{\cdot}7402$ (f.t. one slip) A1

Note: Answer only with no working shown earns 0 marks

(*b*)

$\int_0^{\pi/3} \sin^2 x\, dx = \int_0^{\pi/3} 1\, dx - \int_0^{\pi/3} \cos^2 x\, dx$ M1

$\int_0^{\pi/3} \sin^2 x\, dx = 0{\cdot}3070$ (f.t. candidate's answer to (*a*)) A1

Note: Answer only with no working shown earns 0 marks

2012 Summer

1. (*a*)

0	1		
0·25	1·064494459		
0·5	1·284025417		
0·75	1·755054657	(5 values correct)	B2
1	2·718281828	(3 or 4 values correct)	B1

Correct formula with $h = 0{\cdot}25$ M1

$I \approx \frac{0{\cdot}25}{3} \times \{1 + 2{\cdot}718281828 + 4(1{\cdot}064494459 + 1{\cdot}755054657) + 2(1{\cdot}284025417)\}$

$I \approx 17{\cdot}56452913 \times 0{\cdot}25 \div 3$

$I \approx 1{\cdot}463710761$

$I \approx 1{\cdot}4637$ (f.t. one slip) A1

Note: Answer only with no working shown earns 0 marks

(*b*)

$\int_0^1 e^{x^2+3}\,dx = e^3 \times \int_0^1 e^{x^2}\,dx$ M1

$\int_0^1 e^{x^2+3}\,dx = 29{\cdot}399$ (f.t. candidate's answer to (*a*)) A1

Note: Answer only with no working shown earns 0 marks

2013 Winter

1.

1	0·211941557		
1·25	0·182137984		
1·5	0·154280773		
1·75	0·128955672		
2	0·106506978	(5 values correct)	B2

(If B2 not awarded, award B1 for either 3 or 4 values correct)

Correct formula with $h = 0{\cdot}25$ M1

$I \approx \frac{0{\cdot}25}{3} \times \{0{\cdot}211941557 + 0{\cdot}106506978 + 4(0{\cdot}182137984 + 0{\cdot}128955672) + 2(0{\cdot}154280773)\}$

$I \approx 1{\cdot}871384705 \times 0{\cdot}25 \div 3$

$I \approx 0{\cdot}155948725$

$I \approx 0{\cdot}156$ (f.t. one slip) A1

Note: Answer only with no working earns 0 marks

2013 Summer

1. (*a*)

1	1·945910149		
1·5	2·238046572		
2	2·63905733		
2·5	3·073850053		
3	3·496507561	(5 values correct)	B2

(**If B2 not awarded**, award B1 for either 3 or 4 values correct)

Correct formula with $h = 0{\cdot}5$ M1

$I \approx \frac{0{\cdot}5}{3} \times \{1{\cdot}945910149 + 3{\cdot}496507561 + 4(2{\cdot}238046572 + 3{\cdot}073850053) + 2(2{\cdot}63905733)\}$

$I \approx 31{\cdot}96811887 \times 0{\cdot}5 \div 3$

$I \approx 5{\cdot}328019812$

$I \approx 5{\cdot}328$ (f.t. one slip) A1

Note: Answer only with no working earns 0 marks

(*b*)

$\int_1^3 \ln\sqrt{(x^3 + 6)}\,dx \approx 2{\cdot}664$ (f.t. candidate's answer to (*a*)) B1

2014 Winter

1. (*a*)

0	0		
$\pi/12$	0·071796769		
$\pi/6$	0·333333333		
$\pi/4$	1		
$\pi/3$	3	(5 values correct)	B2

(**If B2 not awarded**, award B1 for either 3 or 4 values correct)

Correct formula with $h = \pi/12$ M1

$I \approx \frac{\pi/12}{3} \times \{0 + 3 + 4(0{\cdot}071796769 + 1) + 2(0{\cdot}333333333)\}$

$I \approx 7{\cdot}953853742 \times (\pi/12) \div 3$

$I \approx 0{\cdot}69410468$

$I \approx 0{\cdot}6941$ (f.t. one slip) A1

Note: Answer only with no working shown earns 0 marks

(*b*) $\int_0^{\pi/3} \sec^2 x \, dx = \int_0^{\pi/3} 1 \, dx + \int_0^{\pi/3} \tan^2 x \, dx$ M1

$\int_0^{\pi/3} \sec^2 x \, dx = 1{\cdot}7413$ (f.t. candidate's answer to (*a*)) A1

Note: Answer only with no working shown earns 0 marks

2014 Summer

1. (*a*)

0	2·197224577		
0·75	2·314217179		
1·5	2·524262696		
2·25	2·861499826		
3	3·335254744	(5 values correct)	B2

(If B2 not awarded, award B1 for either 3 or 4 values correct)

Correct formula with $h = 0{\cdot}75$ M1

$I \approx \frac{0{\cdot}75}{3} \times \{2{\cdot}197224577 + 3{\cdot}335254744 + 4(2{\cdot}314217179 + 2{\cdot}861499826) + 2(2{\cdot}524262696)\}$

$I \approx 31{\cdot}28387273 \times 0{\cdot}75 \div 3$

$I \approx 7{\cdot}820968183$

$I \approx 7{\cdot}82$ (f.t. one slip) A1

Note: Answer only with no working shown earns 0 marks

(*b*) $\int_0^3 \ln(16 + 2e^x) \, dx = \int_0^3 \ln(8 + e^x) \, dx + \int_0^3 \ln 2 \, dx$ M1

$\int_0^3 \ln(16 + 2e^x) \, dx = 7{\cdot}82 + 2{\cdot}08 = 9{\cdot}90$

(f.t. candidate's answer to (*a*)) A1

Note: Answer only with no working shown earns 0 marks

2015

1. (*a*)

0	0		
$\pi/9$	$-0{\cdot}062202456$		
$2\pi/9$	$-0{\cdot}266515091$		
$\pi/3$	$-0{\cdot}693147181$		
$4\pi/9$	$-1{\cdot}750723994$	(5 values correct)	B2

(If B2 not awarded, award B1 for either 3 or 4 values correct)

Correct formula with $h = \pi/9$ M1

$$I \approx \frac{\pi/9}{3} \times \{0 + (-1{\cdot}750723994) + 4[(-0{\cdot}062202456) + (-0{\cdot}693147181)] + 2(-0{\cdot}266515091)\}$$

$I \approx -5{\cdot}305152724 \times (\pi/9) \div 3$

$I \approx -0{\cdot}617282549$

$I \approx -0{\cdot}6173$ (f.t. one slip) A1

Note: Answer only with no working shown earns 0 marks

(*b*)

$\int_0^{4\pi/9} \ln(\sec x)\,dx \approx 0{\cdot}6173$ (f.t. candidate's answer to (*a*)) B1

2016

1. (*a*)

0	1		
$\pi/20$	$1{\cdot}025402923$		
$\pi/10$	$1{\cdot}111347018$		
$3\pi/20$	$1{\cdot}296432399$		
$\pi/5$	$1{\cdot}695307338$	(5 values correct)	B2

(If B2 not awarded, award B1 for either 3 or 4 values correct)

Correct formula with $h = \pi/20$ M1

$$I \approx \frac{\pi/20}{3} \times \{1 + 1{\cdot}695307338 + 4(1{\cdot}025402923 + 1{\cdot}296432399) + 2(1{\cdot}111347018)\}$$

$I \approx 14{\cdot}20534263 \times (\pi/20) \div 3$

$I \approx 0{\cdot}7437900006$

$I \approx 0{\cdot}74379$ (f.t. one slip) A1

Note: Answer only with no working shown earns 0 marks

(*b*) $\int_0^{\pi/5} e^{\sec^2 x}\,dx = e^1 \times \int_0^{\pi/5} e^{\tan^2 x}\,dx$ M1

$\int_0^{\pi/5} e^{\sec^2 x}\,dx \approx 2{\cdot}02183$ (f.t. candidate's answer to (*a*)) A1

Note: Answer only with no working shown earns 0 marks

2017

1. (*a*)

5	3·258096538		
5·5	3·442019376		
6	3·610917913		
6·5	3·766997233		
7	3·912023005	(5 values correct)	B2

(**If B2 not awarded**, award B1 for either 3 or 4 values correct)

Correct formula with $h = 0{\cdot}5$ M1

$I \approx \frac{0{\cdot}5}{3} \times \{3{\cdot}258096538 + 3{\cdot}912023005 + 4(3{\cdot}442019376 + 3{\cdot}766997233) + 2(3{\cdot}610917913)\}$

$I \approx 43{\cdot}22802181 \times 0{\cdot}5 \div 3$

$I \approx 7{\cdot}204670301$

$I \approx 7{\cdot}2$ (f.t. one slip) A1

Note: Answer only with no working earns 0 marks

(*b*) $\int_5^7 \ln\left[\frac{3}{\sqrt{(1+x^2)}}\right] dx = \int_5^7 \ln 3\,dx - \frac{1}{2}\int_5^7 \ln(1+x^2)\,dx$ M1

$\frac{1}{2}\int_5^7 \ln(1+x^2)\,dx \approx 3{\cdot}6$ (f.t. candidate's answer to (*a*)) B1

$\int_5^7 \ln\left[\frac{3}{\sqrt{(1+x^2)}}\right] dx \approx 2{\cdot}2 - 3{\cdot}6 = -1{\cdot}4$

(f.t. candidate's answer to (*a*)) A1