OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4776:** Numerical Methods

Mark Scheme for January 2011

Oxford Cambridge and RSA Examinations

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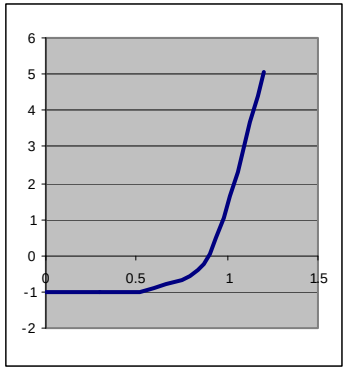
Question			Answer	Marks	Guidance
1	(i)		x LHS RHS 1 2 > 1.557408 1.2 2.2 < 2.572152	M1 A1 **[2]**	no explicit explanation required
	(ii)		r 0 1 2 3 4 x_r 1.1 0.96476 0.442927 –0.52564 –1.58007	M1 A1 **[2]**	$r = 3$ required
	(iii)		e.g. re-arrange to $x = \arctan(1 + x)$ r 0 1 2 3 4 5 x_r 1.1 1.126377 1.131203 1.132076 1.132233 1.132261 1.132	B1 M1 A1 A1 **[4]**	
2			h | M | T 2 | *1.987467* | *1.354440* 1 | *1.830595* | **1.670954** 0.5 | | **1.750774** Simpson's rule $(2M + T) / 3$ **1.776458** **1.777381** Reference to justification/accuracy : 1.777 or 1.78	*T:* M1A1A1 *S*: M1A1A1 E1 A1 **[8]**	Lose 1 for any additional 'answer'(s) but do not penalise extrapolation
3	(i)		$h = 1$ $g'(0) = (2.0100 – 1.4509)/1 = 0.5591$ $h = 0.5$ $g'(0) = (1.6799 – 1.4509)/0.5 = 0.458$ Estimate with smaller h (0.458) likely to be more accurate: smaller h is more accurate (provided there is no great loss of significant figures)	B1 B1 B1 E1 **[4]**	
	(ii)		$h = 0.5$ $g'(0.5) = (2.0100 – 1.4509)/1 = 0.5591$ This estimate, central diff, likely to be more accurate than either of the forward diffs	M1 E1 **[2]**	

Question			Answer	Marks	Guidance
4	(i)		Max poss loss: 365 (or 366) times 0.01 pence: = 3.65 (or 3.66) pence Arises if each daily amount would round up but gets chopped down Average loss 1.825 (or 1.83) pence, because average is half of max.	B1 E1 B1 E1 **[4]**	
	(ii)		£150 000 divided by 1.825 pence: about 8.2 million (8 million) accounts	M1 A1 **[2]**	
5			x P(x) ΔP(x) Δ^2P(x) Δ^3P(x) *–1* *–11* **1** **–10** *1* **3** **3** **13** *12* **5** **44** **41** **28** *16* **7** **129** **85** **44** **16** **9** **274** **145** **60** **16** *11* *495* *221* *76* *16* **(i)** bold: Diff table 3rd diffs constant so cubic **(ii)** italic: working forwards working backwards	M1 A1 E1 B1 M1 A1 M1 A1 **[4] + [4]**	
6	(i)		x f g h abs err g rel err g abs err h rel err h 0.2 0.013351 0.013333 0.013423 –0.0000179 –0.0013424 0.0000716 0.0053600 0.1 0.003334 0.003333 0.003339 –0.0000011 –0.0003339 0.0000045 0.0013350 A1 A1 A1 A1 A1 A1 A1	abs M1 rel M1 **[9]**	f, g, h values may be implied
	(ii)		Errors in g and h are of opposite sign; g is about 4 times as accurate as h. x f (4g + h)/5 abs err rel err 0.2 0.013351 0.013351 –2.5E–08 –1.9E–06 0.1 0.003334 0.003334 –4E–10 –1.2E–07 A1 A1 A1	E1 E1 M1 **[6]**	
	(iii)		x / sin $x \approx 1.000\,000\,002 \approx 1$ $g(10^{-4}) = 3.33 \times 10^{-9}$ Subtraction of nearly equal quantities	B1 B1 E1 **[3]**	

Question			Answer	Marks	Guidance
7	(i)		f(0) = –1f(1) = 1 (hence root) f '(x) = $7x^6 + 5x^4$ which is zero only at $x = 0$. Convincing argument that this is not a turning point No turning points implies no other roots.  	B1 M1 A1 B1 E1 G2 **[7]**	
	(ii)		NR iteration: $x_{r+1} = x_r – (x_r^7 + x_r^5 – 1) / (7x_r^6 + 5x_r^4)$ r 0 1 2 x_r 0.6 1.51756 1.289164 On graph: tangent at 0.6, intersection at 1.5, ordinate & tangent, intersection at 1.3	B1 A1 A1 G4 **[7]**	
	(iii)		r 0 1 2 x_r 0.3 22.1703 19.00128 Comment: e.g. converging but initially very slow (or difficult to tell with only 2 iter'ns) r 0 1 2 x_r 0.9 0.890174 0.889891 Comment: e.g. almost converged, root very close to 0.89	 A1 E1 A1 E1 **[4]**	

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