Question Number	Scheme	Notes	Marks
4.	Given $f(x) = 2x^3 - \frac{7}{x^2} + 16$, $x \neq 0$; Roots α, β: $-2 \leq \alpha \leq -1$ and $0.6 \leq \beta \leq 0.7$		
(a) **Way 1**	$f(-1.5) = ...$	Attempts to evaluate $f(-1.5)$	M1
	$f(-1.75) = ...$	**dependent on the previous M mark** Evaluates $f(-1.75)$ (and not $f(-1.25)$)	dM1
	$f(-2) = -1.75$ **or** $f(-1) = 7$ $f(-1.5) = 6.1388...$ or $\frac{221}{36}$ $f(-1.75) = 2.9955...$ or $\frac{671}{224}$ so interval is $[-2, -1.75]$	**dependent on the 2 previous marks** **Both** • $f(-2)$ correct or correct awrt (or truncated) to 1sf or $f(-1) = 7$ **and** • $f(-1.5)$ and $f(-1.75)$ correct or correct awrt (or truncated) to 1 sf **and** the correct interval stated **Note:** Allow $-2 \leq x \leq -1.75$ or $-2 < x < -1.75$ or $-2 \leq \alpha \leq -1.75$ or $-2 < \alpha < -1.75$ or $[-2, -1.75]$ or $(-2, -1.75)$ equivalent in words. Condone $-2 - -1.75$ Allow a mixture of "ends". Do not allow incorrect statements such as $-1.75 < \alpha < -2$ or $(-1.75, -2)$ or $-1.75 - -2$ unless they are recovered. Ignore the subsequent iteration of $f(-1.875)$	A1
	Note that some candidates only indicate the sign of f and not its value. **In this case the M marks can still score as defined but not the A mark.**		**(3)**
(a) **Way 2**	**Common approach in the form of a table (use the mark scheme above)** a | $f(a)$ | b | $f(b)$ | $\frac{a+b}{2}$ | $f\left(\frac{a+b}{2}\right)$ -2 | -1.75 | -1 | 7 | -1.5 | $6.1388...$ -2 | -1.75 | -1.5 | $6.1388...$ | -1.75 | $2.9955...$ so interval is $-2 \leq \alpha \leq -1.75$ **would score full marks in part (a)**		
(b)	$f'(x) = 6x^2 + 14x^{-3}$	At least one of either $2x^3 \to \pm Ax^2$ or $-\frac{7}{x^2} \to \pm Bx^{-3}$; $A, B \neq 0$	M1
		Correct differentiation which can be simplified or un-simplified	A1
	$\left\{\beta \simeq 0.65 - \frac{f(0.65)}{f'(0.65)}\right\} \Rightarrow \beta \simeq 0.65 - \frac{-0.01879733728...}{53.51360719...}$	**dependent on the previous M mark** Valid attempt at Newton-Raphson using their values of $f(0.65)$ and $f'(0.65)$	dM1
	$\{\beta = 0.6503512623...\} \Rightarrow \beta = 0.6504$ (4 dp)	**dependent on all 3 previous marks** 0.6504 on their first iteration (Ignore any subsequent iterations)	A1 **cso** **cao**
	Correct differentiation followed by a correct answer of 0.6504 scores full marks in part (b) **Correct answer with no working scores no marks in part (b)**		**(4)**
			7

Question 4 Notes

4. (a)	**Note**	Give 2nd M0 and A0 for evaluating both $f(-1.25)$ and $f(-1.75)$
	Note	Do not allow "interval = $f(-2)$ to $f(-1.75)$" unless recovered.
	Note	A method of evaluating $f(-1.5)$ followed by $f(-1.75)$ with ***no evidence*** of evaluating at least one of either $f(-2)$ or $f(-1)$ is M1 dM1 A0.
	Note	Do not confuse the -1.75 in $f(-2) = -1.75$ with the -1.75 in $(-2, -1.75)$

	Question 4 Notes Continued	
4. (b)	**dM1**	This mark can be implied by applying at least one correct ***value*** of either $\mathrm{f}(0.65)$ or their $\mathrm{f}'(0.65)$ (where $\mathrm{f}'(0.65)$ is found using their $\mathrm{f}'(x)$) to 1 significant figure in $0.65 - \dfrac{\mathrm{f}(0.65)}{\mathrm{f}'(0.65)}$. So just $0.65 - \dfrac{\mathrm{f}(0.65)}{\mathrm{f}'(0.65)}$ with an incorrect answer and no other evidence scores final dM0A0.
	Note	If you see $0.65 - \dfrac{\mathrm{f}(0.65)}{\mathrm{f}'(0.65)} = 0.6504$ with no algebraic differentiation, then send the response to review.
	Note	You can imply the M1 A1 marks for algebraic differentiation for either • $\mathrm{f}'(0.65) = 6(0.65)^2 + 14(0.65)^{-3}$ • $\mathrm{f}'(0.65)$ applied correctly in $\beta \simeq 0.65 - \dfrac{2(0.65)^3 - \dfrac{7}{(0.65)^2} + 16}{6(0.65)^2 + 14(0.65)^{-3}}$
	Note	**Differentiating INCORRECTLY to give** $\mathrm{f}'(x) = 6x^2 - 14x^{-3}$ leads to $\beta \simeq 0.65 - \dfrac{-0.01879733728...}{-48.44360719...} = 0.6496119749... = 0.6496$ (4 dp) **This response should be awarded M1 A0 dM1 A0**
	Note	**Differentiating INCORRECTLY to give** $6x^2 - 14x^{-3}$ and $\beta \simeq 0.65 - \dfrac{\mathrm{f}(0.65)}{\mathrm{f}'(0.65)} = 0.6496$ is **M1 A0 dM1 A0**