Question Number	Scheme	Marks
2(a)	$\left(\text{f}(2)=\right)2^4-5(2)^2+4(2)-7=-3<0$ **and** $\left(\text{f}(3)=\right)3^4-5(3)^2+4(3)-7=41>0$	M1
	There is a change of sign and f(x) is continuous so there is a root (in the interval) *	A1*
		(2)
(b)	$x^3=\dfrac{5x^2-4x+7}{x}\Rightarrow x=\sqrt[3]{\dfrac{5x^2-4x+7}{x}}$ *	B1*
		(1)
(c)(i)	$x_2=\sqrt[3]{\dfrac{5(2)^2-4(2)+7}{2}}$	M1
	$=$ awrt 2.1179	A1
(ii)	$\alpha=$ awrt 2.1565	A1
		(3)
		(6 marks)

(a)

M1: Attempts both $\text{f}(2)$ and $\text{f}(3)$ or a narrower interval that contains the root 2.1565…and considers the signs. Note showing $\text{f}(2)\times\text{f}(3)<0$ or "< 0", "> 0" beside each appropriate root is a consideration of signs and is also sufficient for the "sign change" part of reasoning for the A1.

For the substitution, need to see the values substituted or at least one of f(2) or f(3) correct.

A1*: This mark requires:

- both $\text{f}(2)$ and $\text{f}(3)$ correct e.g. f (2) = –3 and f (3) = 41
- a reference to the sign change
- a reference to continuity
- a (minimal) conclusion

For **sign change**, allow equivalent statements e.g. f (2).f (3) < 0, f (2) < 0 < f (3) etc.

For **continuity**, allow just "continuous" and allow "assuming it is continuous" and "continuous equation" but do **not** allow incorrect statements such as "x is continuous", "the interval is continuous", "there is a change of sign therefore it is continuous"

For the **conclusion**, allow e.g. ✓, #, QED, hence shown, hence root, so it crosses the x-axis, etc., but **not** incorrect statements e.g. so there is a root in the interval $[-3, 41]$

You may have to use your judgement to decide if the A1 conditions are satisfied.

Example: f(2) = –3, f(3) = 41, there is a change of sign hence f(x) has a continuous root in [2, 3] Scores M1A0 – i.e. it is not the root that is continuous

(b)

B1*: Proceeds to given answer with no errors and with $x^3 = ...$ seen at some stage.

Condone omission of the fraction bar e.g. $x = \sqrt[3]{\dfrac{5x^2 - 4x + 7}{x}}$ as long as there are no algebraic errors. Be tolerant if the radical does not fully encompass the expression but score B0 if the expression is clearly incorrect e.g. $x = \dfrac{\sqrt[3]{5x^2 - 4x + 7}}{x}$ i.e. where the cube root clearly sits on top of the fraction bar.

Condone working backwards as long as there is a (minimal) conclusion e.g.

$x = \sqrt[3]{\dfrac{5x^2 - 4x + 7}{x}} \Rightarrow x^3 = \dfrac{5x^2 - 4x + 7}{x} \Rightarrow x^4 - 5x^2 + 4x - 7 = 0$ ✓, #, QED, hence shown, etc.

(c)(i)

M1: Attempts to find x_2 using the given iteration formula. Allow for sight of $\sqrt[3]{\dfrac{5(2)^2 - 4(2) + 7}{2}}$

Must see the correct index and not $\sqrt{\dfrac{5(2)^2 - 4(2) + 7}{2}}$ unless the "3" is implied by their value(s). May be implied by awrt 2.118 or awrt 2.147 $(= x_3)$

A1: awrt 2.1179 (apply isw if necessary)

(ii)

A1: awrt 2.1565 (provided M1 scored in (c)(i)) (apply isw if necessary)

Question Number	Scheme	Marks
3(a)	$\log_{10} D = 1.04 + 0.38t \Rightarrow D = 10^{1.04+0.38t}$ **or** $a = 10^{1.04}$ or $b = 10^{0.38}$	M1
	$a =$ awrt 10.96 **or** $b =$ awrt 2.399	A1
	$D = 10.96 \times 2.399^t$	A1
		(3)
(b)	$45000 = "10.96" \times "2.399"^T \Rightarrow T = ...$ or $\log_{10} 45000 = 1.04 + 0.38T \Rightarrow T = ...$	M1
	awrt 9.51	A1
		(2)
(c)	$D = "10.96" \times "2.399"^{12} \Rightarrow D = ...$ or $\log_{10} D = 1.04 + 0.38 \times 12 \Rightarrow D = ...$ or $350000 = "10.96" \times "2.399"^t \Rightarrow t = ...$ or $\log_{10} 350000 = 1.04 + 0.38 \times t \Rightarrow t = ...$	M1
	D = awrt (£)400 000 $\Rightarrow$ yes or t = awrt 11.9 $\Rightarrow$ yes	A1
		(2)
		(7 marks)

(a)

M1: A correct application of log laws to obtain $D = 10^{1.04+0.38t}$ or forms one correct equation for a or b e.g. $a = 10^{1.04}$ or $b = 10^{0.38}$. May be implied by a = awrt 11 or b = awrt 2.4

A1: One of $a =$ awrt 10.96, $b =$ awrt 2.399. May be seen embedded in their equation.

A1: Correct **equation** with correct awrt values e.g. $D = (awrt\,10.96) \times (awrt\,2.399)^t$

Do <u>not</u> allow recovery from incorrect work e.g.

$\log_{10} D = 1.04 + 0.38t \Rightarrow D = 10^{1.04} + 10^{0.38t} \Rightarrow a = 10.96,\ b = 2.399 \Rightarrow D = 10.96 \times 2.399^t$

Scores M1A1A0

Note that *a* and *b* may be found in other ways e.g.

$$t = 0 \Rightarrow a = D = 10^{1.04},\ t = 1 \Rightarrow b = \frac{D}{a} = \frac{10^{1.42}}{10^{1.04}} = 10^{0.38}$$