Question Number	Scheme	Marks
4 (a)	$f(x)=4x^3+13x^2-10x+8$ $x-2\overline{)4x^3+13x^2-10x+8}$ $\quad 4x^2+21x+32$ $4x^3-8x^2$ $21x^2-10x$ $21x^2-42x$ $32x+8$ $32x-64$ 72 Synthetic Division $2 \mid 4 \quad 13 \quad -10 \quad 8$ $\quad\quad 8 \quad 42 \quad 64$ $4 \quad 21 \quad 32 \mid 72$	
(i)	$Q(x)=4x^2+21x+32$	M1, A1
(ii)	$R=72$	M1, A1 **(4)**
(b)(i)	Attempts $f(-4)=4\times-64+13\times16-10\times-4+8$ $=-256+208+40+8=0$ Hence $(x+4)$ is a factor *	M1 A1*
(ii)	$f(x)=4x^3+13x^2-10x+8=(x+4)(4x^2-3x+2)$	M1
	For their $4x^2-3x+2$ attempts "b^2-4ac"$=9-32$, $b^2-4ac'<0$ so $4x^2-3x+2$ has no real roots and $f(x)=0$ has one at $x=-4$	M1 A1* **(5)**
(c)	$(f'(x))=12x^2+26x-10=2(3x-1)(2x+5)$ $-\frac{5}{2}<x<\frac{1}{3}$	M1 dM1, A1 **(3)** **(12 marks)**

(a) (i)

M1: Attempts to divide $f(x)$ by $(x-2)$ and achieves a 3TQ quotient of the form $4x^2+bx+c \quad b\neq 0, c\neq 0$ **AND** a remainder that is a constant. See equivalent form using synthetic division

A1: Achieves a Quotient or $Q(x)=4x^2+21x+32$. It is implied if they write (i) $4x^2+21x+32$

It cannot just be awarded from the expression within the division sum

(a) (ii)

M1: Attempts to divide $f(x)$ by $(x-2)$ and achieves a 3TQ quotient **AND** a remainder that is a constant.
Alternatively attempts to find the value of $f(2)$. Allow $f(2)=72$ but if it is incorrect you must see some evidence for the award such as showing an intermediate line of $4\times 2^3+13\times 2^2-10\times 2+8$
or else $32+52-20+8$ (or equivalent) condoning slips. See equivalent form using synthetic division

A1: States that Remainder or *R* = 72. It is implied if they write (ii) 72
It cannot just be awarded from sight of 72 within the division sum BUT if a candidate gets the division sum completely correct and does not state $Q(x)=4x^2+21x+32$ and *R* = 72 (o.e.) they should be awarded SC 1,1,1,0

Alt (a) via an identity BUT other acceptable methods exist such as by inspection which is a less formal version of this.

Sets up a correct identity $f(x)=4x^3+13x^2-10x+8\equiv(x-2)\left(Ax^2+Bx+C\right)+R$ **AND then**

M1: Compares terms and achieves $A=4$ and values for *B* and *C*

A1: States that Quotient, (i) or $Q(x)=4x^2+21x+32$

M1: Finds *R* via f(2) or solving $8=R\pm 2C$ with their value for C.

A1: States that Remainder, (ii) or *R* = 72

(b)(i)

M1: Attempts to find the value of $f(-4)$. For this to be awarded you must see some values. Look for, for example,

- $f(-4)=4\times(-4)^3+13\times(-4)^2-10\times(-4)+8$ with or without the brackets
- $f(-4)=-256+208+40+8$ condoning slips

You must be convinced that they have attempted $f(-4)$ and not $f(+4)$

Note that dividing $f(x)=4x^3+13x^2-10x+8$ by $(x+4)$ is M0 as it doesn't satisfy the demand of the question.

Note that simply stating $f(-4)=0$ without sight of evidence (e.g. intermediate values) is M0

A1*: Requires

- The award of M1
- Sight of correct values or correct expression, e.g. $\mathrm{f}(-4) = -256 + 208 + 40 + 8$ or $\mathrm{f}(-4) = 4\times(-4)^3 + 13\times(-4)^2 - 10\times(-4) + 8$ (must be correct bracketing) followed by = 0
- and a minimal conclusion which may be QED, hence true, ✓

(b)(ii). Mark part (b) as one complete section. Work in part (i) can count in part (ii)

Although the question states hence, these marks can be awarded independently of (b)(i) so 00111 is possible

M1: Divides $\mathrm{f}(x)$ by $(x+4)$ and achieves an acceptable 3 term quadratic factor

If division is used look for first two terms $4x^2 - 3x + ...$

If they are using inspection, look for first and last terms $(x+4)\left(4x^2 + ...x + 2\right)$

M1: Makes a valid attempt at finding the roots or number of roots of their 3-term quadratic factor resulting from factoring out or dividing by (x+4) . Look for an attempt at the value of "$b^2 - 4ac$" or an attempt at the correct quadratic formula o.e. such as completing the square. It is dependent upon them having a quadratic factor of the form $4x^2 + bx + c, b \neq 0, c \neq 0$

A1*: This requires all of the following;

- a correct division (o.e.) leading to the correct quadratic factor
- a correct 'proof' showing that $4x^2 - 3x + 2$ hasn't any real roots e.g. "$b^2 - 4ac$" $= 9 - 32 < 0$ or attempting to solve $4x^2 - 3x + 2 = 0$ via the quadratic formula followed by 'not possible' o.e.
- a minimal reason/statement showing that $\mathrm{f}(x) = 0$ has only one real solution. This could be a statement that the one (real) solution is $x = -4$ or reasons that the one real solution is as a result of $(x+4) = 0$

There can be no incorrect statements in the body of their proof. Eg. The real solution is $(x+4)$

(c) **This is a non-calculator question/part question**

M1: Attempts to differentiate and find the roots. This requires all of

- Differentiation to a 3TQ expression with at least one correct term. FYI $\left(\mathrm{f}'(x)\right)=12x^2+26x-10$
- A valid non calculator attempt at finding the two critical values of $\mathrm{f}'(x)=0$. Look for a valid attempt to factorise or use the quadratic formula in an attempt to solve $\mathrm{f}'(x)=0$. Condone attempts in which the factor of 2 disappears. E.g. $12x^2+26x-10=0\Rightarrow(2x+5)(3x-1)=0$

dM1: Finds the inside region for their quadratic. It is dependent upon the previous M mark

A1: $-\frac{5}{2}<x<\frac{1}{3}$ or $-\frac{5}{2}$,, x,, $\frac{1}{3}$ o.e. such as $\left(-\frac{5}{2},\frac{1}{3}\right)$

SC: Candidates who use a calculator can be awarded SC 1,1,0 for an otherwise completely correct solution.

E.g. $\mathrm{f}'(x)=12x^2+26x-10<0\Rightarrow -2.5<x<\frac{1}{3}$

Question Number	Scheme	Marks
5(i)	$4\tan\theta+5\sin\theta=0$	
	States or uses $\tan\theta=\dfrac{\sin\theta}{\cos\theta}\rightarrow 4\dfrac{\sin\theta}{\cos\theta}+5\sin\theta=0$	M1
	$\sin\theta\left(4+5\cos\theta\right)=0$	
	$\cos\theta=-\dfrac{4}{5}$	dM1
	$\cos\theta=-\dfrac{4}{5}\Rightarrow\theta=$ awrt $143°$ or awrt $217°$	A1
	$\cos\theta=-\dfrac{4}{5}\Rightarrow\theta=$ awrt $143.1°$ and awrt $216.9°$	A1
	$\sin\theta=0\Rightarrow\theta=180°,360°$	B1
		(5)
(ii)	$\dfrac{\sin x}{\cos x}+\dfrac{\cos x}{\sin x}=\dfrac{5}{\cos x}\overset{\times\sin x\cos x}{\Rightarrow}\sin^2 x+\cos^2 x=5\sin x$	
	$5\sin x=1$	M1, A1
	$x=$ awrt $0.201, 2.94$	dM1, A1
		(4)
		(9 marks)

(i) Condone a lack of a degrees symbol throughout. Condone solutions that drop θ's in their working

M1: States $\tan\theta=\dfrac{\sin\theta}{\cos\theta}$ or attempts to use $\tan\theta=\dfrac{\sin\theta}{\cos\theta}$ in the given equation.

Condone slips in coefficients but writing $4\tan\theta$ as $\dfrac{4\sin\theta}{4\cos\theta}$ is M0.

dM1: Attempts all of the following

- uses $\tan\theta=\dfrac{\sin\theta}{\cos\theta}$ condoning slips in the coefficients
- multiplies by $\cos\theta$ and proceeds to a linear equation in $\cos\theta$ via factorising or cancelling out the term in $\sin\theta$
- achieves $\cos\theta=k$ where $|k|<1$

A1: Achieves $\cos\theta=-\dfrac{4}{5}$ and finds one correct value for θ to the nearest degree or in radians to one dp. So, allow for example, awrt 2.5(0) following $\cos\theta=-\dfrac{4}{5}$

A1: Achieves $\cos\theta=-\dfrac{4}{5}$ and finds both θ values in degrees correct to one dp.

awrt $143.1°$ and awrt $216.9°$