Question	Scheme	Marks
2.	$f(z) = 2z^3 + pz^2 + qz - 41$	
(a)	$(z =) 5 + 4i$	**B1**
		(1)
(b)	$z = 5 \pm 4i \Rightarrow (z - (5+4i))(z - (5-4i)) = ...$ Or e.g. Sum of roots = 10, Product of roots = 41	**M1**
	$z^2 - 10z + 41$	**A1**
	$f(z) = (z^2 - 10z + 41)(2z + ...)$	**M1**
	$\Rightarrow z = \frac{1}{2}, (5 \pm 4i)$	**A1**
		(4)
(c)	$f(z) = (z^2 - 10z + 41)(2z - 1) = \ldots$	**M1**
	$p = -21$, $q = 92$	**A1**
		(2)
(d)	Area $= \frac{1}{2} \times 8 \times \left(5 - "\frac{1}{2}"\right)$	**M1**
	$= 18$	**A1ft**
		(2)
		(Total 9 marks)

Notes Mark (b) and (c) together

(a)

B1: Correct complex number

(b)

M1: Correct strategy to find the quadratic factor using the conjugate pair.

A1: Correct quadratic factor.

M1: Attempts to find the linear factor. Look for $2z + k$ where k is number (or allow if k is in terms of p as long as a value of p is also found at some stage). May arise from attempts at long division.

A1: Correct real root (condone if labelled x). The complex roots do not have to be stated. Must be seen in (b) (or (c) if done together).

(c)

M1: Multiplies out to obtain values for p and q. May have been found as part of a long division process in (b).

A1: Correct values. May be seen embedded in the cubic.

(d)

M1: For $\frac{1}{2} \times 8 \times \left|5 - \text{their}"\frac{1}{2}"\right|$ where their real root is non-zero.

A1ft: Correct area (follow through their non-zero real root).

Alt 1 **(b)**	Product of complex roots = 41, Product of all roots = $\frac{\pm 41}{2}$	**M1**
	Product of complex roots = 41, Product of all roots = $\frac{41}{2}$	**A1**
	$z = \frac{\text{Product of roots of f}(z)}{\text{Product of complex roots}} = \frac{41}{2} \div 41$	**M1**
	$\Rightarrow z = \frac{1}{2}, (5 \pm 4\text{i})$	**A1**
		(4)
(c)	$\frac{p}{2} = -\sum \alpha_i \quad \frac{q}{2} = \sum \alpha_i \alpha_j \Rightarrow p = ..., q = ...$	**M1**
	$p = -21$, $q = 92$	**A1**
		(2)

Notes

Alt 1 (b)

M1: Identifies the product of roots of f(z) up to sign error, and the product of complex roots.

A1: Correct products seen or implied.

M1: Attempts to find the third root of f(z).

A1: Correct real root. The complex roots do not have to be stated. Must be seen in (b) (or (c) if done together)

(c)

M1: Applies sum and pair sum properties, or multiplies out to obtain values for p and q.

A1: Correct values. May be seen embedded in the cubic.

Alt 2 **(b)**	$\text{f}(5 \pm 4\text{i}) = -230 \pm 472\text{i} + p(9 \pm 40\text{i}) + q(5 \pm 4\text{i}) - 41 = 0$ $\Rightarrow -271 + 9p + 5q = 0, 472 + 40p + 4q = 0$	**M1** **A1**
	$\Rightarrow p = ..., q = ... \Rightarrow \text{f}(z) = 2z^3 + "p"z^2 + "q"z - 41 \Rightarrow z = ...$	**M1**
	$\Rightarrow z = \frac{1}{2}, (5 \pm 4\text{i})$	**A1**
		(4)
(c)	$\Rightarrow p = ..., q = ...$	**M1**
	$p = -21$, $q = 92$	**A1**
		(2)

Notes Alt (b)+(c) together

Alt 2 (b)

M1: Attempts factor theorem with one of the complex roots **and** equates real and imaginary terms to produce simultaneous equations.

A1: Correct equations.

M1: Uses their p and q from solving the simultaneous equations in f(z) and solves the cubic (may just see roots).

A1: Correct real root. The complex roots do not have to be stated. Must be seen in (b) (or (c) if done together)

(c)

M1: Awarded before previous M. Solves their simultaneous equations to obtain values for p and q.

A1: Correct values. May be seen embedded in the cubic.