

Question	Scheme	Marks	AOs
2(a)	$f(-3) = 2(-3)^3 + 5(-3)^2 + 2(-3) + 15$ $= -54 + 45 - 6 + 15$	M1	1.1b
	$f(-3) = 0 \Rightarrow (x + 3)$ is a factor	A1	2.4
		(2)	
(b)	At least 2 of: $a = 2, b = -1, c = 5$	M1	1.1b
	All of: $a = 2, b = -1, c = 5$	A1	1.1b
		(2)	
(c)	$b^2 - 4ac = (-1)^2 - 4(2)(5)$	M1	2.1
	$b^2 - 4ac = -39$ which is < 0 so the quadratic has no real roots so $f(x) = 0$ has only 1 real root	A1	2.4
		(2)	
(d)	$(x =) 2$	B1	2.2a
		(1)	

(7 marks)

Notes

(a)

M1: Attempts $f(-3)$. Attempted division by $(x + 3)$ or $f(3)$ is M0
Look for evidence of embedded values or two correct terms of
 $f(-3) = -54 + 45 - 6 + 15 = \dots$

A1: Achieves and states $f(-3) = 0$, and makes a suitable conclusion. Sight of $f(x) = 0$ when
 $x = -3$ is also acceptable.

It must follow M1. Accept, for example, $f(-3) = 0 \Rightarrow (x + 3)$ is a factor

This may be seen in a preamble before finding $f(-3) = 0$ but in these cases there must be a minimal statement ie QED, "proved", tick etc.

(b)

M1: Correct method implied by values for at least 2 correct constants. Allow embedded in their $f(x)$ or within their working if they use algebraic division/other methods which may be seen in part (a) and used in part (b).

A1: All values correct. Allow embedded in their $f(x)$ or seen as the quotient from algebraic division. Isw incorrectly stated values of a b and c following a correct quadratic expression seen.

$$x+3 \overline{) 2x^3 + 5x^2 + 2x + 15}$$

$$2x^3 + 6x^2$$

$$-x^2 + 2x$$

$$-x^2 - 3x \quad \text{scores M1A1}$$

$$5x + 15$$

$$5x + 15$$

$$0$$

(c)

M1: Either:

- considers the discriminant using their a , b and c (does not need to be evaluated) $(b^2 - 4ac =) (-1)^2 - 4(2)(5)$ (the $(-1)^2$ may appear as 1^2 and condone missing brackets for this mark for -1^2). Discriminant = -39 is sufficient for M1
- attempts to complete the square so score for $2\left(x \pm \frac{1}{4}\right)^2 + \dots$
- attempts to find the roots of the quadratic using the formula. The values embedded in the formula score this mark.

$$\frac{1 \pm \sqrt{(-1)^2 - 4 \times 2 \times 5}}{2 \times 2} \quad \text{(the } (-1)^2 \text{ may appear as } 1^2 \text{ and condone missing brackets}$$

for this mark for -1^2)

- Sketches a graph of the quadratic. It must be a U shaped quadratic which does not cross the x -axis.

A1: Provides a correct explanation from correct working. They must

- Have a correct calculation
- Explanation that the quadratic has no (real) roots
- Minimal conclusion stating that $f(x) = 0$ has only one root

eg $b^2 - 4ac = -39 < 0$ so only one root is M1A0 (needs to explain the quadratic has no real roots)

eg $2\left(x - \frac{1}{4}\right)^2 + \frac{39}{8} > 0$ so **no real roots** (for the quadratic) so $(f(x))$ has **only one** (real)

root is M1A1

The value of the discriminant, completed square form $2\left(x - \frac{1}{4}\right)^2 + \frac{39}{8}$ or roots of the

quadratic $\left(= \frac{1 \pm \sqrt{39}i}{4} \right)$ must be correct.

If they sketch the quadratic graph it must be a U shaped quadratic which crosses the y -axis at 5 and has a minimum in the 1st quadrant. They must explain that the graph does not cross the x -axis so no real roots for the quadratic so only one root for $f(x) = 0$.

(d)

B1: 2 condone (2, 0)