Question	Scheme	Marks	AOs
4 (a)	States or uses $a = 4$	B1	1.1a
	Valid method to find $Q(x)$	M1	2.1
	$(x+4)(2x^2 - 5x + 4)$	A1	1.1b
		(3)	
(b)	Attempts to show that their $2x^2 - 5x + 4$ does not have any (real) roots	M1	3.1a
	Correct calculations, reason and conclusion	A1	2.1
		(2)	
			(5 marks)

Notes:

(a)

B1: States or uses $a = 4$ e.g. may be seen in their attempt at dividing algebraically by $x + 4$

M1: Attempts to divide f (x) by $(x+4)$ to find a three-term quadratic $Q(x)$. There are various methods or ways to present their solution so typically methods

- by inspection look for $2x^3 + 3x^2 - 16x + 16 = (x+4)(2x^2 + ...x \pm 4)$
- by division look for a quadratic quotient of $2x^2 - 5x \pm ...$

A1: $(x+4)(2x^2 - 5x + 4)$ condone the missing trailing bracket i.e. $(x+4)(2x^2 - 5x + 4$ isw if they attempt to factorise their quadratic factor.

Allow to be scored if seen in (b).

(b)

M1: Attempts to show that their three-term quadratic "$2x^2 - 5x + 4$" does not have any roots:

- **Attempts the discriminant**
  e.g. $b^2 - 4ac = 25 - 4 \times 2 \times 4 \; (= -7)$ (may be embedded in the quadratic formula)
- **Attempts to use the quadratic formula**
  e.g. $(x =) \dfrac{5 \pm \sqrt{(-5)^2 - 4 \times 2 \times 4}}{4}$ but do not allow directly from a calculator $\dfrac{5 \pm \sqrt{7}i}{4}$
- **Attempts to complete the square**
  e.g. $2x^2 - 5x + 4 = 2\left(x^2 - \dfrac{5}{2}x\right) + 4 = 2\left(x - \dfrac{5}{4}\right)^2 + ... \quad \left(= 2\left(x - \dfrac{5}{4}\right)^2 - \dfrac{25}{8} + 4\right)$
- **Uses calculus to find the turning point**
  e.g. $\dfrac{\mathrm{d}(2x^2 - 5x + 4)}{\mathrm{d}x} = 4x - 5 = 0 \Rightarrow x = \dfrac{5}{4} \Rightarrow y = ...$

Note that any attempts using the discriminant or quadratic formula must have the values embedded in the correct places (may be partially evaluated) to score M1

A1: **Dependent on a correct** $Q(x) = 2x^2 - 5x + 4$

Fully correct argument that requires:

- Fully correct work
- A justification depending on strategy and no incorrect reasoning seen
- A conclusion

Examples below – Note we must see working before they proceed to a correct root or minimum value – see M1 for guidance

Strategy	**Correct work examples**	**Justification examples**	**Conclusion examples**
Via discriminant	$b^2 - 4ac = -7$	$-7 < 0$ -7 so no (real) roots but NOT $-7 \neq 0$ so no roots	so "-4 is the only (real) root" / "only one (real) root"
Via using the quadratic formula	$x = \dfrac{5 \pm \sqrt{7}i}{4}$ or $x = \dfrac{5 \pm \sqrt{-7}}{4}$	$-7 < 0$ / which is not possible / complex roots o.e. / cannot square root a negative / no (real) roots	
Via completing the square	$2\left(x - \dfrac{5}{4}\right)^2 + \dfrac{7}{8}$ or $2\left(x - \dfrac{5}{4}\right)^2 + \dfrac{7}{8} = 0 \Rightarrow$ $2\left(x - \dfrac{5}{4}\right)^2 = -\dfrac{7}{8}$	which has a minimum value of $\dfrac{7}{8}$ / minimum (of the positive quadratic) is above the x-axis $-\dfrac{7}{8} < 0$ / cannot square root a negative / no (real) roots	
Via calculus	$x = \dfrac{5}{4} \Rightarrow y = \dfrac{7}{8}$	which has a minimum value of $\dfrac{7}{8}$ / minimum (of the positive quadratic) is above the x-axis	

Note that it is possible to justify and conclude in one step by using phrases e.g. "**no more** (real) roots" or "**no other** (real) roots"

e.g. $2x^2 - 5x + 4 \Rightarrow b^2 - 4ac = 25 - 32 = -7$ so no more roots which scores M1A1

Condone $25 - 32 < 0$ as a justification that the quadratic has no real roots

Condone the conclusion -4 is the only (real) solution (instead of (real) root).

Note if $(x+4)$ is described as a root or -4 is described as a factor this scores A0