

Question	Scheme	Marks	AOs
11 (a)	Attempts $f(4) = 2 \times 4^3 - 13 \times 4^2 + 8 \times 4 + 48$	M1	1.1b
	$f(4) = 0 \Rightarrow (x-4)$ is a factor	A1	1.1b
		(2)	
(b)	$2x^3 - 13x^2 + 8x + 48 = (x-4)(2x^2 \dots x - 12)$	M1	2.1
	$= (x-4)(2x^2 - 5x - 12)$	A1	1.1b
	Attempts to factorise quadratic factor or solve quadratic eqn	dM1	1.1b
	$f(x) = (x-4)^2(2x+3) \Rightarrow f(x) = 0$ has only two roots, 4 and -1.5	A1	2.4
		(4)	
(c)	Deduces either three roots or deduces that $f(x)$ is moved down two units	M1	2.2a
	States three roots, as when $f(x)$ is moved down two units there will be three points of intersection (with the x - axis)	A1	2.4
		(2)	
(d)	For sight of $k = \pm 4, \pm \frac{3}{2}$	M1	1.1b
	$k = 4, -\frac{3}{2}$	A1ft	1.1b
		(2)	

(10 marks)

Notes

(a)

M1: Attempts to calculate $f(4)$.

Do not accept $f(4) = 0$ without sight of embedded values or calculations.

If values are not embedded look for two correct terms from $f(4) = 128 - 208 + 32 + 48$

Alternatively attempts to divide by $(x-4)$. Accept via long division or inspection.

See below for awarding these marks.

A1: Correct reason with conclusion. Accept $f(4) = 0$, hence factor as long as M1 has been scored.

This should really be stated on one line after having performed a correct calculation. It could appear as a preamble if the candidate states "If $f(4) = 0$, then $(x-4)$ is a factor before doing the calculation and then writing hence proven or \checkmark oe.

If division/inspection is attempted it must be correct and there must be some attempt to explain why they have shown that $(x-4)$ is a factor. Eg Via division they must state that there is no remainder, hence factor

(b)

M1: Attempts to find the quadratic factor by inspection (correct first and last terms) or by division (correct first two terms)

So for inspection award for $2x^3 - 13x^2 + 8x + 48 = (x-4)(2x^2 \dots x \pm 12)$

$$x-4 \overline{) \begin{array}{r} 2x^2 - 5x \\ 2x^3 - 13x^2 + 8x + 48 \end{array}}$$

For division look for $\frac{2x^3 - 8x^2}{-5x^2}$

A1: Correct quadratic factor $(2x^2 - 5x - 12)$ For division award for sight of this "in the correct place" You don't have to see it paired with the $(x-4)$ for this mark.

If a student has used division in part (a) they can score the M1 A1 in (b) as soon as they start attempting to factorise their $(2x^2 - 5x - 12)$.

dM1: Correct attempt to solve or factorise their $(2x^2 - 5x - 12)$ including use of formula

Apply the usual rules $(2x^2 - 5x - 12) = (ax+b)(cx+d)$ where $ac = \pm 2$ and $bd = \pm 12$

Allow the candidate to move from $(x-4)(2x^2 - 5x - 12)$ to $(x-4)^2(2x+3)$ for this mark.

A1: Via factorisation

Factorises twice to $f(x) = (x-4)(2x+3)(x-4)$ or $f(x) = (x-4)^2(2x+3)$ or

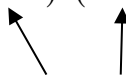
$f(x) = 2(x-4)^2 \left(x + \frac{3}{2}\right)$ followed by a valid explanation why there are only two roots.

The explanation can be as simple as

- hence $x=4$ and $-\frac{3}{2}$ (only). The roots must be correct
- only two distinct roots as 4 is a repeated root

There must be some understanding between roots and factors.

E.g. $f(x) = (x-4)^2(2x+3)$



only two distinct roots is insufficient.

This would require two distinct factors, so there are two distinct roots.

Via solving.

Factorsises to $(x-4)(2x^2 - 5x - 12)$ and solves $2x^2 - 5x - 12 = 0 \Rightarrow x = 4, -\frac{3}{2}$ followed

by an explanation that the roots are $4, 4, -\frac{3}{2}$ so only two distinct roots.

Note that this question asks the candidate to use algebra so you cannot accept any attempt to use their calculators to produce the answers.

(c)

M1: For a valid **deduction**.

Accept **either** there are 3 roots **or** states that it is a solution of $f(x) = 2$ or $f(x) - 2 = 0$

A1: Fully explains:

Eg. States three roots, as $f(x)$ is moved down by **two** units (giving three points of intersection with the x -axis)

Eg. States three roots, as it is where $f(x) = 2$ (You may see $y = 2$ drawn on the diagram)

Notes on Question 11 continue

(d)

M1: For sight of ± 4 **and** $\pm \frac{3}{2}$ Follow through on \pm their roots.

A1ft: $k = 4, -\frac{3}{2}$ Follow through on their roots. Accept $4, -\frac{3}{2}$ but not $x = 4, -\frac{3}{2}$