Question	Scheme	Marks	AOs
11 (a)	Attempts $f(4)=2\times4^3-13\times4^2+8\times4+48$	M1	1.1b
	$f(4)=0\Rightarrow(x-4)$ is a factor	A1	1.1b
		(2)	
(b)	$2x^3-13x^2+8x+48=(x-4)(2x^2...x-12)$	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 $k=\pm4,\pm\frac{3}{2}$	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 ✓ 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)

Notes on Question 11 continue

So for inspection award for $2x^3-13x^2+8x+48=(x-4)(2x^2...x\pm12)$

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

For division look for $\quad 2x^3-8x^2$

$$\underline{}\qquad -5x^2$$

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 $ac=\pm2$ and $bd=\pm12$

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. $\quad f(x)=(x-4)^2(2x+3)$

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