Question	Scheme	Marks	AOs
6(a)	$f(x) = ax^3 + bx^2 + 18x + 9$		
	$f(-3) = 0$	M1	1.1b
	$f(-3) = -27a + 9b - 54 + 9 = 0$ $$-3a + b = 5 *$$	A1*	2.1
		(2)	

(a) Notes

M1: Attempts $f(-3) = 0$ leading to an equation in a and b only. Condone slips.

The $= 0$ may be implied by further work for this mark.

A1*: Simplifies and rearranges to the given answer with no errors. There must be at least one **correct** line of working before the given answer and $= 0$ must be correctly seen at some point in their solution or at the start e.g. stating $f(-3) = 0$.

Isw if they achieve the given answer but then attempt to make a or b the subject.

Minimum acceptable is e.g. $-27a + 9b - 54 + 9 = 0 \Rightarrow -3a + b = 5 *$

Note: $-27a + 9b - 54 + 9 \Rightarrow -3a + b = 5$ is M1A0* (we do not see $= 0$ correctly at some point or e.g. $f(-3) = 0$)

Allow invisible brackets to be recovered e.g. $a \times -3^3 = -27a$

Allow attempts to divide algebraically and tabular/grid/inspection methods e.g.

Long division:

$$
\begin{array}{r}
ax^2 + (b-3a)x + (18 - 3b + 9a) \\
x+3 \overline{)ax^3 + bx^2 + 18x + 9} \\
ax^3 + 3ax^2 \\
(b-3a)x^2 + 18x + 9 \\
(b-3a)x^2 + 3(b-3a)x \\
(18 - 3b + 9a)x + 9 \\
(18 - 3b + 9a)x + 3(18 - 3b + 9a) \\
9 - 54 + 9b - 27a = 0
\end{array}
$$

M1: For an attempt to divide algebraically by $(x + 3)$. Condone slips but they must have a quadratic quotient of the form $ax^2 + (...a + ...b)x$ and proceed to a remainder of the form $...a + ...b + ...$ which is then set $= 0$

Grid method:

	ax^2	$(b-3a)x$	$18 - 3b + 9a$
x	ax^3	$(b-3a)x^2$	$(18 - 3b + 9a)x$
3	$3ax^2$	$3(b-3a)x$	$54 - 9b + 27a$

So $9 - (54 - 9b + 27a) = 0$

M1: Condone slips but they must have a quadratic quotient of the form $ax^2 + (...a + ...b)x$ and the bottom right hand cell of the form $...a + ...b + ...$ which is then subtracted from 9 and set $= 0$

Inspection:

$$ax^3 + bx^2 + 18x + 9 = (x+3)(ax^2 + (b-3a)x + 3) \Rightarrow 3(b-3a) + 3 = 18$$

M1: Condone slips but they must have a quadratic factor of the form $ax^2 + (...a + ...b)x + 3$ and then extract the x terms and set $= 18$

In all cases, A1 is scored for fully correct work leading to the given equation.

(b)	$ax^3 \to \dots x^2$, $bx^2 \to \dots x$ or $18x \to 18$	M1	1.1b
	$\left(f'(x)=\right)3ax^2+2bx+18$	A1	1.1b
	$\left(f'(2)=\right)3a(2)^2+2b(2)+18=14$	dM1	1.1b
	$-3a+b=5$ and $3a+b=-1$ leading to $a=\dots$ and $b=\dots$	ddM1	3.1a
	$a=-1$ and $b=2$	A1	2.2a
		(5)	

(b)

M1: Decreases the power of x by one for at least one of the terms.
Look for $ax^3 \to \dots x^2$, $bx^2 \to \dots x$ or $18x \to 18$ but not $9 \to 0$

A1: $\left(f'(x)=\right)3ax^2+2bx+18$

dM1: Substitutes $x=2$ into their derivative and sets equal to 14 to create a second equation in a
and b e.g. $3a(2)^2+2b(2)+18=14$

ddM1: Attempts to solve simultaneously their equation in a and b obtained from using $f'(2)=14$
and the given equation from part (a) to obtain values for a and b.
Condone copying slips when using the equation from (a) as long as the intention is clear.
You do not need to check their working and this may be done on a calculator.

A1: cao $a=-1$ and $b=2$ only.
Generally, candidates who use $f(2)=14$ or e.g. $f'(2)=0$ will score a maximum of
M1A1dM0ddM0A0 in (b).

Note that some candidates may use the result in (a) and substitute to eliminate a or b before
differentiating e.g.:

$f(x)=ax^3+bx^2+18x+9, \ -3a+b=5 \Rightarrow f(x)=ax^3+(3a+5)x^2+18x+9$
$\Rightarrow f'(x)=3ax^2+2(3a+5)x+18 \Rightarrow 14=12a+12a+20+18 \Rightarrow a=-1$

Or

$f(x)=ax^3+bx^2+18x+9, \ -3a+b=5 \Rightarrow f(x)=\left(\dfrac{b-5}{3}\right)x^3+bx^2+18x+9$

$\Rightarrow f'(x)=3\left(\dfrac{b-5}{3}\right)x^2+2bx+18 \Rightarrow 14=4b-20+4b+18 \Rightarrow b=2$

Score

M1: As main scheme

A1: Correct derivative in terms of a or b

dM1: Substitutes $x=2$ into their derivative and sets equal to 14 to create an equation in a or b

ddM1: Solves to obtain a value for a or b and then finds the other value.

A1: As main scheme