QUESTION NUMBER

DO NOT WRITE IN THIS MARGIN

10.(a)

	x^4	x^3	x^2	x	n
-5	1	3	-7	9	-30
	↓	-5	10	-15	30
	1	-2	3	-6	0

since $R = 0$, $(x+5)$ is a factor

10.(b)

$$(x+5)(x^3 - 2x^2 + 3x - 6) = 0$$

	x^3	x^2	x	n
2	1	-2	3	-6
	↓	2	0	6
	1	0	3	0

since $R = 0$, $(x+2)$ is a factor

$$(x+5)(x-2)(x^2+3) = 0$$

$x = -5$ $\quad x = 2$ $\quad x^2 + 3 = 0$ has no real solutions

$(b^2 - 4ac = -12)$

<table>
<tr><th>Question</th><th>Generic scheme</th><th>Illustrative scheme</th><th>Max mark</th></tr>
<tr><td>10. (a)</td><td>•[1] use -5 in synthetic division or evaluation of quartic</td><td>•[1]
$\begin{array}{r|rrrrr} -5 & 1 & 3 & -7 & 9 & -30 \\ \hline & 1 & & & & \boxed{} \end{array}$
or
$(-5)^4+3\times(-5)^3-7\times(-5)^2$
$+9\times(-5)-30$</td><td>2</td></tr>
<tr><td></td><td>•[2] complete division/evaluation and interpret result</td><td>•[2]
$\begin{array}{r|rrrrr} -5 & 1 & 3 & -7 & 9 & -30 \\ & & -5 & 10 & -15 & 30 \\ \hline & 1 & -2 & 3 & -6 & \boxed{0} \end{array}$
Remainder $=0 \therefore (x+5)$ is a factor
OR
$f(-5)=0 \therefore (x+5)$ is a factor</td><td></td></tr>
</table>

Notes:

1. Communication at •[2] must be consistent with working at that stage i.e. a candidate's working must arrive legitimately at 0 before •[2] can be awarded.
2. Accept any of the following for •[2]:
   - '$f(-5)=0$ so $(x+5)$ is a factor'
   - 'since remainder $=0$, it is a factor'
   - the '0' from any method linked to the word 'factor' by 'so', 'hence', $\therefore$, $\rightarrow$, $\Rightarrow$ etc.
3. Do not accept any of the following for •[2]:
   - double underlining the '0' or boxing the '0' without comment
   - '$x=-5$ is a factor', '… is a root'
   - the word 'factor' only, with no link.

Commonly Observed Responses:

Candidate A - grid method

	x^3			
x	x^4	$-2x^3$		
5	$5x^3$			

•[1] ✓

	x^3	$-2x^2$	$+3x$	-6
x	x^4	$-2x^3$	$+3x^2$	$-6x$
5	$5x^3$	$-10x^2$	$+15x$	-30

with no remainder

$\therefore (x+5)$ is a factor •[2] ✓

Candidate B - grid method

	x^3			
x	x^4	$-2x^3$		
5	$5x^3$			

•[1] ✓

	x^3	$-2x^2$	$+3x$	-6
x	x^4	$-2x^3$	$+3x^2$	$-6x$
5	$5x^3$	$-10x^2$	$+15x$	-30

$\therefore (x+5)(x^3-2x^2+3x-6)=x^4+3x^3-7x^2+9x-30$

$\therefore (x+5)$ is a factor •[2] ✓

Question			Generic scheme	Illustrative scheme	Max mark
10.	(b)		•[3] identify cubic and attempt to factorise	•[3] eg $\begin{array}{r\|rrrr} 1 & 1 & -2 & 3 & -6 \\ & & 1 & -1 & \\ \hline & 1 & -1 & & \boxed{} \end{array}$ or $\begin{array}{r\|rrrr} 2 & 1 & -2 & 3 & -6 \\ & & 2 & 0 & \\ \hline & 1 & 0 & & \boxed{} \end{array}$	**5**
			•[4] find second factor	•[4] $\begin{array}{r\|rrrr} 2 & 1 & -2 & 3 & -6 \\ & & 2 & 0 & 6 \\ \hline & 1 & 0 & 3 & \boxed{0} \end{array}$ leading to $(x-2)$ or $x=2$	
			•[5] identify quadratic	•[5] x^2+3	
			•[6] interpret lack of solutions of quadratic	•[6] $b^2-4ac=-12<0$ $\therefore$ no (further real) solutions OR $x^2=-3$ or ~~$x^2=-3$~~ $\therefore$ no (further real) solutions	
			•[7] state solutions	•[7] $x=-5,\ x=2$	

Notes:

4. Candidates who arrive at $(x+5)(x-2)(x^2+3)$ by using algebraic long division or by inspection gain •[3], •[4] and •[5].
5. Evidence for •[6] may appear in the quadratic formula.
6. At •[6] accept interpretations such as "no further roots", "no solutions" and "cannot factorise further" with justification.
7. At •[6] accept $x=\sqrt{-3}$ **leading to** "not possible" and "not real".
8. Where there is no reference to b^2-4ac accept '$-12<0$ so no real roots' **with the remaining roots stated** for •[6] - see candidates E and F.
9. Do not accept any of the following for •[6]:
   - $(x+5)(x-2)(x^2+3)$ no further roots/cannot factorise further.
   - $(x+5)(x-2)(\ldots\ \ldots)(\ldots\ \ldots)$ no further roots/cannot factorise further.
10. Where the quadratic factor obtained at •[5] can be factorised, •[6] and •[7] are not available.
11. •[7] is only available where •[6] has been awarded.

Question	Generic scheme	Illustrative scheme	Max mark
10.(continued)			

Commonly Observed Responses:

Candidate C

$(x+5)(x-2)(x^2+3)$ $\bullet^5$ ✓

$b^2-4ac=0-12<0$ $\bullet^6$ ✓

so no solutions

$x=-5$, $x=2$ $\bullet^7$ ✓

Candidate D

$(x+5)(x-2)(x^2+3)$ $\bullet^5$ ✓

$b^2-4ac<0$ $\bullet^6$ ^

so no solutions

$x=-5$, $x=2$ $\bullet^7$ ✓2

Candidate E

$(x+5)(x-2)(x^2+3)$ $\bullet^5$ ✓

$-12<0$ $\bullet^6$ ✓

so no solutions

$x=-5$, $x=2$ $\bullet^7$ ✓

Candidate F

$(x+5)(x-2)(x^2+3)$ $\bullet^5$ ✓

$-12<0$

so no solutions $\bullet^6$ ^ $\bullet^7$ ^

Candidate G - grid method

(a)

	x^3	$-2x^2$	$3x$	-6
x	x^4	$-2x^3$	$+3x^2$	$-6x$
5	$5x^3$	$-10x^2$	$+15x$	-30

(b)

	x^2	…	…
x	x^3	…	…
…	…	…	…

$\bullet^3$ ✓

$\bullet^3$ is awarded for evidence of the cubic expression (which may be in the grid from part (a)) **AND** the terms in the diagonal boxes summing to the second and third terms in the cubic respectively.

	x^2	$0x$	3
x	x^3	0	$3x$
-2	$-2x^2$	0	-6

$\bullet^4$ ✓

$(x+5)(x-2)(x^2+3)$ $\bullet^5$ ✓

$b^2-4ac=-12<0$

$\therefore$ no more solutions $\bullet^6$ ✓

$x=-5$, $x=2$ $\bullet^7$ ✓