<p>| | | |</p>
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| 1 | \( c = 6 \)  
   \( k = -7 \) |   | 1 | M1 for \( f(2) = 0 \) used or for long division as far as \( x^3 - 2x^2 \) in working | 3 |
| 2 | (i) \( (x + 1)(2x - 3) = 9 \) o.e.  
   \( 2x^2 - x - 3 = 18 \) or \( x^2 - \frac{1}{2}x - 3/2 = 9 \)  
   (ii) \( (x - 7)(x + 3) \)  
   -3 and \( \frac{7}{2} \) o.e. or ft their factors base 4, height 4.5 o.e. cao | M1 | for clear algebraic use of \( \frac{1}{2} bh \); condone \( (x + 1)(2x - 3) = 18 \)  
   allow \( x \) terms uncollected.  
   NB ans \( 2x^2 - x - 21 = 0 \) given  
   NB B0 for formula or comp. sq.  
   if factors seen, allow omission of -3  
   B0 if also give \( b = -9, h = -2 \) | 5 |
| 3 | \( f(2) = 3 \) seen or used  
   \( 2^3 + 2k + 5 = 3 \) o.e.  
   \( k = -5 \) | M1 | allow M1 for divn by \( (x - 2) \) with \( x^2 + 2x + (k + 4) \) or \( x^2 + 2x - 1 \) obtained  
   alt: M1 for \( (x - 2)(x^2 + 2x - 1) + 3 \) (may be seen in division) then M1dep (and B1) for \( x^3 - 5x + 5 \)  
   alt divn of \( x^3 + kx + 2 \) by \( x - 2 \) with no rem. | 3 |
| 4 | \( f(1) \) used  
   \( 1^3 + 3 \times 1 + k = 6 \)  
   \( k = 2 \) | M1 | or division by \( x - 1 \) as far as \( x^2 + x \)  
   or remainder = \( 4 + k \)  
   B3 for \( k = 2 \) www | 3 |
<table>
<thead>
<tr>
<th></th>
<th>5 + 2k soi</th>
<th>M1</th>
<th>A1</th>
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<tbody>
<tr>
<td>k</td>
<td>12</td>
<td></td>
<td></td>
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<tr>
<td>attempt at f(3)</td>
<td></td>
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<tr>
<td>27 + 36 + m = 59 o.e.</td>
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<tr>
<td>m = −4 cao</td>
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**M1**
- allow M1 for expansion with $5x^3 + 2kx^3$ and no other $x^3$ terms
- or M1 for $(29 − 5) / 2$ soi

**A1**
- must substitute 3 for $x$ in cubic not product
- or long division as far as obtaining $x^2 + x$ in quotient
- or from division $m − (−63) = 59$ o.e.
- or for $27 + 3k + m = 59$ or ft their $k$
| 6 (i) | trials of at calculating \( f(x) \) for at least one factor of 30  
details of calculation for \( f(2) \) or \( f(-3) \) or \( f(-5) \)  
attempt at division by \((x - 2)\) as far as \(x^3 - 2x^2\) in working  
correctly obtaining \(x^2 + 8x + 15\)  
factorising a correct quadratic factor  
\((x - 2)(x + 3)(x + 5)\) | **M1** | **M0** for division or inspection used  
A1 | **M0** for division or inspection used  
A1 | **M0** for division or inspection used  
A1 |

| 6 (ii) | sketch of cubic right way up, with two turning points  
values of intns on x axis shown, correct \((-5, -3, \text{and} 2)\) or ft from their factors/roots in (i)  
y-axis intersection at \(-30\) | **B1** | 0 if stops at \(x\)-axis  
B1 | 0 if stops at \(x\)-axis  
B1 | 0 if stops at \(x\)-axis  
B1 | 0 if stops at \(x\)-axis |

|  | or equiv for \((x + 3)\) or \((x + 5)\); or inspection with at least two terms of quadratic factor correct  
or B2 for another factor found by factor theorem  
for factors giving two terms of quadratic correct; M0 for formula without factors found  
condone omission of first factor found; ignore ‘= 0’ seen  
allow last four marks for \((x - 2)(x + 3)(x + 5)\) obtained; for all 6 marks must see factor theorem use first |

|  | or equiv for \((x + 3)\) or \((x + 5)\); or inspection with at least two terms of quadratic factor correct  
or B2 for another factor found by factor theorem  
for factors giving two terms of quadratic correct; M0 for formula without factors found  
condone omission of first factor found; ignore ‘= 0’ seen  
allow last four marks for \((x - 2)(x + 3)(x + 5)\) obtained; for all 6 marks must see factor theorem use first |

|  | or equiv for \((x + 3)\) or \((x + 5)\); or inspection with at least two terms of quadratic factor correct  
or B2 for another factor found by factor theorem  
for factors giving two terms of quadratic correct; M0 for formula without factors found  
condone omission of first factor found; ignore ‘= 0’ seen  
allow last four marks for \((x - 2)(x + 3)(x + 5)\) obtained; for all 6 marks must see factor theorem use first |
<p>| 6 (iii) | $(x - 1)$ substituted for $x$ in either form of eqn for $y = f(x)$ | M1 | correct or ft their (i) or (ii) for factorised form; condone one error; allow for new roots stated as $-4, -2$ and $3$ or ft $(x - 1)^3$ expanded correctly (need not be simplified) or two of their factors multiplied correctly or M1 for correct or correct ft multiplying out of all 3 brackets at once, condoning one error $[x^3 - 3x^2 + x^2 + 2x^2 + 8x - 6x - 12x - 24]$ unless all 3 brackets already expanded, must show at least one further interim step allow SC1 for $(x + 1)$ subst and correct exp of $(x + 1)^3$ or two of their factors ft or, for those using given answer: M1 for roots stated or used as $-4, -2$ and $3$ or ft A1 for showing all 3 roots satisfy given eqn B1 for comment re coefft of $x^3$ or product of roots to show that eqn of translated graph is not a multiple of RHS of given eqn |</p>
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<tr>
<td>7</td>
<td>f(−2) used −8 + 36 − 40 + 12 = 0</td>
<td>M1</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>divn attempted as far as ( x^2 + 3x ) ( x^2 + 3x + 2 ) or ( (x + 2)(x + 1) )</td>
<td>M1</td>
<td>2</td>
</tr>
<tr>
<td>iii</td>
<td>( (x + 2)(x + 6)(x + 1) )</td>
<td>A1</td>
<td>2</td>
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<td>iv</td>
<td>sketch of cubic the right way up through 12 marked on y axis intercepts (-6, -2, -1) on x axis ( x(x^2 + 9x + 20) ) ( x(x + 4)(x + 5) ) ( x = 0, -4, -5 )</td>
<td>G1</td>
<td>2</td>
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<tr>
<td>v</td>
<td>or M1 for division by ( (x + 2) ) attempted as far as ( x^3 + 2x^2 ) then A1 for ( x^2 + 7x + 6 ) with no remainder or inspection with ( b = 3 ) or ( c = 2 ) found; B2 for correct answer allow seen earlier; M1 for ( (x + 2)(x + 1) ) with 2 turning pts; no 3rd tp curve must extend to x &gt; 0 condone no graph for ( x &lt; -6 ) or other partial factorisation or B1 for each root found e.g. using factor theorem</td>
<td>M1</td>
<td>3</td>
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<td></td>
<td></td>
<td>A1</td>
<td>3</td>
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