| Question Number | Scheme | Marks |
|---|---|---|
| **4 (a)(i)** | e.g. $f(-3) = 13-9-(k-3)^2 = 4-(k-3)^2$ and states when $k=5$, $f(-3)=0$ | B1* |
| **(a)(ii)** | Uses $f(-3)=0 \Rightarrow (k-3)^2 = 4 \Rightarrow k = (5), 1$ | M1A1 |
| | | **(3)** |
| **(b)(i)** | $13+3x+(x+2)(x+5)^2 = 13+3x+(x+2)(x^2+10x+25) = 13+3x+x^3+....$ | M1 |
| | $= x^3+12x^2+48x+63$ | A1 |
| | Hence $f(x) = (x+3)(x^2+9x+21)$ | dM1A1 |
| | | **(4)** |
| **(b)(ii)** | e.g. Attempts "$b^2-4ac$" for their $(x^2+9x+21)$ | M1 |
| | e.g. $b^2-4ac = -3 < 0 \Rightarrow (x^2+9x+21)$ has no roots and hence $f(x)=0$ has one solution, $-3$ | A1 |
| | | **(2)** |
| | | **(9 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| 4 (a) | $\text{f}(x) = 4x^3 + 13x^2 - 10x + 8$ | |
| | $\begin{array}{r} 4x^2 + 21x + 32 \\ x-2\overline{)4x^3 + 13x^2 - 10x + 8} \\ \underline{4x^3 - 8x^2} \\ 21x^2 - 10x \\ \underline{21x^2 - 42x} \\ 32x + 8 \\ \underline{32x - 64} \\ 72 \end{array}$ <br> Synthetic Division <br> $\begin{array}{c\|cccc} 2 & 4 & 13 & -10 & 8 \\ & & 8 & 42 & 64 \\ \hline & 4 & 21 & 32 & 72 \end{array}$ | |
| (i) | $Q(x) = 4x^2 + 21x + 32$ | M1, A1 |
| (ii) | $R = 72$ | M1, A1 |
| | | **(4)** |
| (b)(i) | Attempts $\text{f}(-4) = 4\times -64 + 13\times 16 - 10\times -4 + 8$ | M1 |
| | $= -256 + 208 + 40 + 8 = 0$ Hence $(x+4)$ is a factor * | A1* |
| (ii) | $\text{f}(x) = 4x^3 + 13x^2 - 10x + 8 = (x+4)(4x^2 - 3x + 2)$ | M1 |
| | For their $4x^2 - 3x + 2$ attempts "$b^2 - 4ac$" $= 9 - 32$, | M1 |
| | $b^2 - 4ac' < 0$ so $4x^2 - 3x + 2$ has no real roots and $\text{f}(x) = 0$ has one at $x = -4$ | A1* |
| | | **(5)** |
| (c) | $(\text{f}'(x)) = 12x^2 + 26x - 10 = 2(3x-1)(2x+5)$ | M1 |
| | $-\frac{5}{2} < x < \frac{1}{3}$ | dM1, A1 |
| | | **(3)** |
| | | **(12 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **3(a)** | $2(-3)^3 - (-3)^2 + A(-3) + B = 55$ <br> or e.g. <br> $-54 - 9 - 3A + B = 55$ | M1 |
| | $-54 - 9 - 3A + B = 55$ <br> $\Rightarrow 3A - B = -118$* | A1* |
| | | **(2)** |

| | | |
|---|---|---|
| **(b)** | $2\left(\frac{5}{2}\right)^3 - \left(\frac{5}{2}\right)^2 + A\left(\frac{5}{2}\right) + B = 0$ | M1 |
| | $3A - B = -118$, $5A + 2B = -50$ <br> $\Rightarrow A = ...,$ **or** $B = ...$ | M1 |
| | $A = -26, B = 40$ | A1 |
| | | **(3)** |

| | | |
|---|---|---|
| (c) | $f(x)=(x-7)(2x^2+\ldots x+\ldots)+\ldots$ | M1 |
| | $2x^2+13x+65$ | A1 |
| | | **(2)** |
| | | **Total 7** |

| Question Number | Scheme | Marks |
|---|---|---|
| **5 (a)** | $f(x)=3x^3+ax^2-10x+b$ | |
| | $f\left(\frac{4}{3}\right)=0 \Rightarrow 3\times\left(\frac{4}{3}\right)^3+a\left(\frac{4}{3}\right)^2-10\left(\frac{4}{3}\right)+b=0$ | M1 |
| | $\frac{64}{9}+\frac{16}{9}a-\frac{40}{3}+b=0 \Rightarrow 64+16a-120+9b=0 \quad \Rightarrow 16a+9b=56$ * | A1* |
| | | **(2)** |
| **(b)** | $f(2)=b \Rightarrow 3\times(2)^3+a(2)^2-10(2)+b=b$ leading to an equation in just $a$ | M1 |
| | $4a=-4 \Rightarrow a=-1$ | A1 |
| | Substitutes $a=$ '$-1$' in $-16+9b=56 \Rightarrow b=\ldots$ | M1 |
| | $\Rightarrow b=8$ | A1 |
| | | **(4)** |
| **(c)** | $f(x)=3x^3-x^2-10x+8=(3x-4)(x^2+x-2)$ | M1, A1 |
| | $=(3x-4)(x+2)(x-1)$ | A1 |
| | | **(3)** |
| | | **(9 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **3(a)** | $2(-3)^3-(-3)^2+A(-3)+B=55$<br>or e.g.<br>$-54-9-3A+B=55$ | M1 |
| | $-54-9-3A+B=55$<br>$\Rightarrow 3A-B=-118$* | A1* |
| | | **(2)** |

| | | |
|---|---|---|
| **(b)** | $2\left(\frac{5}{2}\right)^3-\left(\frac{5}{2}\right)^2+A\left(\frac{5}{2}\right)+B=0$ | M1 |
| | $3A-B=-118$, $5A+2B=-50$<br>$\Rightarrow A=\ldots$, **or** $B=\ldots$ | M1 |
| | $A=-26$, $B=40$ | A1 |
| | | **(3)** |


| | | |
|---|---|---|
| (c) | $f(x)=(x-7)(2x^2+\ldots x+\ldots)+\ldots$ | M1 |
| | $2x^2+13x+65$ | A1 |
| | | **(2)** |
| | | **Total 7** |

| Question Number | Scheme | Marks |
|---|---|---|
| **5 (a)** | $f(x)=3x^3+ax^2-10x+b$ | |
| | $f\left(\frac{4}{3}\right)=0\Rightarrow 3\times\left(\frac{4}{3}\right)^3+a\left(\frac{4}{3}\right)^2-10\left(\frac{4}{3}\right)+b=0$ | M1 |
| | $\frac{64}{9}+\frac{16}{9}a-\frac{40}{3}+b=0\Rightarrow 64+16a-120+9b=0\quad\Rightarrow 16a+9b=56$ * | A1* |
| | | **(2)** |
| **(b)** | $f(2)=b\Rightarrow 3\times(2)^3+a(2)^2-10(2)+b=b$ leading to an equation in just $a$ | M1 |
| | $4a=-4\Rightarrow a=-1$ | A1 |
| | Substitutes $a='-1'$ in $-16+9b=56\Rightarrow b=...$ | M1 |
| | $\Rightarrow b=8$ | A1 |
| | | **(4)** |
| **(c)** | $f(x)=3x^3-x^2-10x+8=(3x-4)(x^2+x-2)$ | M1, A1 |
| | $=(3x-4)(x+2)(x-1)$ | A1 |
| | | **(3)** |
| | | **(9 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| | $f(x)=4x^3+ax^2-29x+b$ | |
| **4.(a)** | Sets $f\left(-\frac{1}{2}\right)=0\rightarrow\ 4\times\left(-\frac{1}{2}\right)^3+a\times\left(-\frac{1}{2}\right)^2-29\times\left(-\frac{1}{2}\right)+b=0$ | M1 |
| | $\Rightarrow\frac{1}{4}a+b+14=0\Rightarrow\ a+4b=-56$ * | A1* |
| | | **(2)** |
| **(b)** | Sets $f(2)=-25\rightarrow\ 4\times2^3+a\times2^2-29\times2+b=-25$ | M1 |
| | $4a+b=1$ | A1 |
| | | **(2)** |
| **(c)** | (i) Solves $a+4b=-56$ with their $4a+b=1\Rightarrow a=...,\ b=...$ | M1 |
| | $a=4,\ b=-15$ | A1 |
| | (ii) $4x^3+4x^2-29x-15=(2x+1)(2x^2+x-15)$ | M1, A1 |
| | $=(2x+1)(2x-5)(x+3)$ cso | A1 |
| | | **(5)** |
| | | **(9 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **11(i)** | E.g. $n=5\Rightarrow 3^5+2=245$ | M1 |
| | 245 is not a prime number<br>or e.g.<br>245 is divisible by 5 so not true | A1 |
| | | **(2)** |

| | | |
|---|---|---|
| **(ii)** | $m = 3k+1 \Rightarrow m^2-1 = (3k+1)^2 - 1 = 9k^2+6k+1-1$ **or** $m = 3k+2 \Rightarrow m^2-1 = (3k+2)^2 - 1 = 9k^2+12k+4-1$ | M1 |
| | $m^2-1 = 9k^2+6k = 3(3k^2+2k)$ **or** $m^2-1 = 9k^2+12k+3 = 3(3k^2+4k+1)$ | A1 |
| | $m = 3k+1 \Rightarrow m^2-1 = (3k+1)^2 - 1 = 9k^2+6k+1-1$ **and** $m = 3k+2 \Rightarrow m^2-1 = (3k+2)^2 - 1 = 9k^2+12k+4-1$ | dM1 |
| | $3(3k^2+2k)$ and $3(3k^2+4k+1)$ are both multiples of 3 so $m^2-1$ must be divisible by 3 when $m$ is not divisible by 3 | A1 |
| | | **(4)** |
| | | **Total 6** |

| Question Number | Scheme | Marks |
|---|---|---|
| **8. (a)** | $-5 < x < \frac{2}{3}$ | M1, A1 **(2)** |
| **(b)** | $(2x-7)$ | B1 **(1)** |
| **(c)** | $f'(x) = 2(3x-2)(x+5) = 6x^2+26x-20$ | |
| | $f(x) = 2x^3+13x^2-20x+c$ | M1, A1 |
| | $x = \frac{7}{2},\quad y/f(x) = 0 \Rightarrow c = (-175)$ | dM1, A1 |
| | $f(x) = 2x^3+13x^2-20x-175 = (2x-7)(x^2+10x+25)$ | ddM1 |
| | $= (2x-7)(x+5)^2$ | A1 **(6)** |
| | | **(9 marks)** |