7.4 (a) $\frac{3}{4}(-2)^4-(-2)^3-9(-2)^2+20$ ***(M1)***

Note: Award ***(M1)*** for substituting $x=-2$ in the function.

$= 4$ ***(A1)(G2)*** ***[2 marks]***

Note: If the coordinates $(-2,\ 4)$ are given as the answer award, at most, ***(M1)(A0)***. If no working shown award ***(G1)***. If $x=-2,\ y=4$ seen then award full marks.

(b) $3x^3-3x^2-18x$ ***(A1)(A1)(A1)*** ***[3 marks]***

Note: Award ***(A1)*** for each correct term, award at most ***(A1)(A1)(A0)*** if extra terms seen.

(c) $f'(3)=3\times(3)^3-3\times(3)^2-18\times3$ ***(M1)***

Note: Award ***(M1)*** for substitution in their $f'(x)$ of $x=3$.

$=0$ ***(A1)***

OR

$3x^3-3x^2-18x=0$ ***(M1)***

Note: Award ***(M1)*** for equating their $f'(x)$ to zero.

$x=3$ ***(A1)***

$f'(x_1)=3\times(x_1)^3-3\times(x_1)^2-18\times x_1<0$ where $0<x_1<3$ ***(M1)***

Note: Award ***(M1)*** for substituting a value of x_1 in the range $0<x_1<3$ into their f' and showing it is negative (decreasing).

$f'(x_2)=3\times(x_2)^3-3\times(x_2)^2-18\times x_2>0$ where $x_2>3$ ***(M1)***

Note: Award ***(M1)*** for substituting a value of x_2 in the range $x_2>3$ into their f' and showing it is positive (increasing).

continued...

Question 7. 4 continued

OR

With or without a sketch:
Showing $f(x_1) > f(3)$ where $x_1 < 3$ and x_1 is close to 3. ***(M1)***
Showing $f(x_2) > f(3)$ where $x_2 > 3$ and x_2 is close to 3. ***(M1)***

Note:	If a sketch of $f(x)$ is drawn **in this part of the question and** $x = 3$ is identified as a stationary point on the curve, then (i) award, at most, ***(M1)(A1)(M1)(M0)*** if the stationary point has been found; (ii) award, at most, ***(M0)(A0)(M1)(M0)*** if the stationary point has not been previously found.

Since the gradients go from negative (decreasing) through zero to positive (increasing) it is a local minimum ***(R1)(AG)***

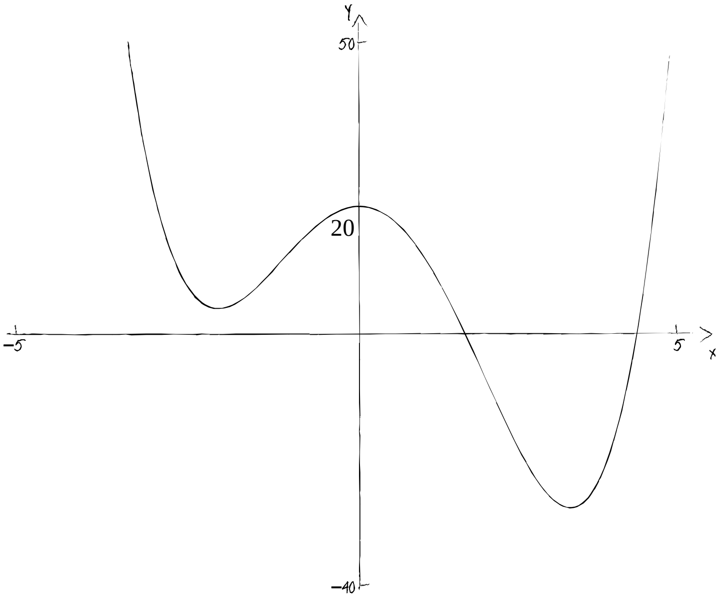
Note:	Only award ***(R1)*** if the first two marks have been awarded *ie* $f'(3)$ has been shown to be equal to 0.

[5 marks]

continued...

Question 74 continued

(d)



(A1)(A1)(A1)(A1)

Notes: Award ***(A1)*** for labelled axes and indication of scale on both axes.
Award ***(A1)*** for smooth curve with correct shape.
Award ***(A1)*** for local minima in 2nd and 4th quadrants.
Award ***(A1)*** for y intercept $(0, 20)$ seen and labelled. Accept 20 on y-axis.
Do **not** award the third ***(A1)*** mark if there is a turning point on the x-axis.
If the derivative function is sketched then award, at most, ***(A1)(A0)(A0)(A0)***.
For a smooth curve (with correct shape) there should be **ONE** continuous thin line, no part of which is straight and no (one to many) mappings of x.

[4 marks]

(e) $(0, 20)$ ***(G1)(G1)***

Note: If parentheses are omitted award ***(G0)(G1)***.

OR

$x = 0,\ y = 20$ ***(G1)(G1)*** ***[2 marks]***

Note: If the derivative function is sketched in part (d), award ***(G1)*(ft)*(G1)*(ft)** for $(-1.12, 12.2)$.

(f) $f'(2) = 3(2)^3 - 3(2)^2 - 18(2)$ ***(M1)***

Notes: Award ***(M1)*** for substituting $x = 2$ into their $f'(x)$.

$= -24$ ***(A1)*(ft)*(G2)*** ***[2 marks]***

continued...

Question 74 continued

(g) (i) Gradient of perpendicular $= \frac{1}{24}$ (0.0417, 0.041666…) ***(A1)*(ft)*(G1)***

Note: Follow through from part (f).

(ii) $y + 12 = \frac{1}{24}(x - 2)$ ***(M1)(M1)***

Note: Award ***(M1)*** for correct substitution of $(2, -12)$, ***(M1)*** for correct substitution of their perpendicular gradient into equation of line.

OR

$-12 = \frac{1}{24} \times 2 + d$ ***(M1)***

$d = -\frac{145}{12}$

$y = \frac{1}{24}x - \frac{145}{12}$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of $(2, -12)$ and gradient into equation of a straight line, ***(M1)*** for correct substitution of the perpendicular gradient and correct substitution of d into equation of line.

$b = -24, c = -290$ ***(A1)*(ft)*(A1)*(ft)*(G3)*** ***[5 marks]***

Note: Follow through from parts (f) and g(i). To award **(ft)** marks, b and c must be integers. Where candidate has used 0.042 from g(i), award ***(A1)*(ft)** for -288.

Total: [23 marks]