| Question Number | Scheme | Marks |
|---|---|---|
| **10(a)** | One of $-\frac{20}{3} < x < -6, \quad x > \frac{3}{2}$ | M1 |
| | Both $-\frac{20}{3} < x < -6, \quad x > \frac{3}{2}$ | A1 |
| | | **(2)** |
| **(b)** | $(3x+20)(x+6)(2x-3) = (3x+20)\left(2x^2+9x-18\right) =$ | M1 |
| | $= 6x^3 + 67x^2 + 126x - 360$ | A1 A1 |
| | | **(3)** |
| **(c)** | $\frac{dy}{dx} = 18x^2 + 134x + 126 \Rightarrow$ Gradient at $x = 0$ is 126 | M1 |
| | Equation of $l$ is $y = 126x - 360$ | A1ft |
| | $l$ cuts $C$ again when $6x^3 + 67x^2 + 126x - 360 = 126x - 360$ | dM1 |
| | $6x^3 + 67x^2 = 0 \Rightarrow x^2(6x+67) = 0$ | ddM1 |
| | $x = -\frac{67}{6}$ | A1 |
| | | **(5)** |
| | | **(10 marks)** |

(a)

**M1:** One of $-\frac{20}{3} < x < -6, \quad x > \frac{3}{2}$. Condone with $< \leftrightarrow \leqslant$ for this mark and allow equivalent notation e.g. $\left(-\frac{20}{3}, -6\right), \quad \left(\frac{3}{2}, \infty\right), \left[-\frac{20}{3}, -6\right], \left[\frac{3}{2}, \infty\right)$

Allow the first inequality to be written separately as e.g. $x > -\frac{20}{3}, \ x < -6$,

$x > -\frac{20}{3}$ and $x < -6$

Condone incorrect notation e.g. $-\frac{20}{3} < \mathrm{f}(x) < -6, \quad \mathrm{f}(x) > \frac{3}{2}$

or e.g. $-\frac{20}{3} < y < -6, \quad y > \frac{3}{2}$

**A1:** Both $-\frac{20}{3} < x < -6, \quad x > \frac{3}{2}$.

Allow the first inequality to be written separately as e.g. $x > -\frac{20}{3}, \ x < -6$ and allow equivalent notation e.g. $\left(-\frac{20}{3}, -6\right), \quad \left[\frac{3}{2}, \infty\right)$ but **not** e.g. $-\frac{20}{3} < \mathrm{f}(x) < -6, \quad \mathrm{f}(x) > \frac{3}{2}$

(b) Allow (b) marks to score anywhere in their solution.

**M1:** Attempts to multiply two brackets to create a quadratic before multiplying by the third to form a cubic

**A1**: $6x^3+\alpha x^2+\beta x\pm 360$ where $\alpha$ and $\beta$ are not both zero.

**A1**: $6x^3+67x^2+126x-360.$ Condone a spurious "= 0" e.g. $6x^3+67x^2+126x-360=0$ but do not isw

e.g. $x^3+\frac{67}{6}x^2+21x-60$ is A0 but see note below.

(c)

**M1:** Attempts the gradient of *l* by differentiating and substituting $x=0$

For the differentiation look for one of $...x^3\to...x^2$, $...x^2\to...x$, $kx\to k$

**A1ft**: Equation of *l* is $y=126x-360$. Follow through on their $y=ax^3+bx^2+cx+d\Rightarrow y=cx+d$

Allow equivalent correct equations e.g. $y+360=126\left(x-0\right)$

**dM1:** Sets the equation of their *l* to their answer for (b). **Depends on the first M mark.**

**ddM1:** Attempts to solve cubic of the form $ax^3+bx^2=0$ by taking out a factor of $x^2$ or e.g. by division by $x^2$ leading to a value for *x*. **Depends on both previous M marks**.

May be implied by e.g. $ax^3+bx^2=0\Rightarrow x=-\frac{b}{a}$

**A1:** $x=-\frac{67}{6}$ and no other solutions apart from *x* = 0 which can be ignored. Ignore any attempts to find *y*.

Note that **<u>just</u>** an incorrect *x* coefficient in the expansion in (b) will result in $x=-\frac{67}{6}$ in (c) if the subsequent work is correct. In such cases allow full recovery in (c).

Similarly, if the expansion in part (b) is e.g. divided by 6 to give $x^3+\frac{67}{6}x^2+21x-60$, allow full recovery in (c) as correct work should lead to the correct answer of $x=-\frac{67}{6}$

| Question Number | Scheme | Marks |
|---|---|---|
| **11(a)** | States or implies that the gradient of the normal is $-\frac{1}{3}$ | M1 |
| | Correct equation of normal e.g. $y-16=-\frac{1}{3}(x-4)$ | A1 |
| | | **(2)** |
| **(b)** | $f''(x)=4x+x^{-\frac{1}{2}} \Rightarrow f'(x)=2x^2+2x^{\frac{1}{2}}+c$ | M1 |
| | $x=4, f'(x)=3 \Rightarrow\ 3=32+4+c \Rightarrow c=...(-33)$ | dM1 |
| | $f'(x)=2x^2+2x^{\frac{1}{2}}-33$ | A1 |
| | $f'(x)=2x^2+2x^{\frac{1}{2}}-33 \Rightarrow f(x)=\frac{2}{3}x^3+\frac{4}{3}x^{\frac{3}{2}}-33x+d$ | dM1 |
| | $x=4, f(x)=16 \Rightarrow (f(x)=)\frac{2}{3}x^3+\frac{4}{3}x^{\frac{3}{2}}-33x+\frac{284}{3}$ | ddM1A1 |
| | | **(6)** |
| | | **(8 marks)** |

(a)

**M1:** States or implies that the gradient of the normal is $-\frac{1}{3}$

**A1**: Finds the <u>equation</u> of the normal $y-16=-\frac{1}{3}(x-4)$ o.e. e.g. $y=-\frac{1}{3}x+\frac{52}{3}$, $3y+x-52=0$

But **not** $\frac{y-16}{x-4}=-\frac{1}{3}$.

Requires a full correct equation. Apply isw once a correct equation is seen.

(b) Award marks if work in (b) is seen in (a).

**M1**: Attempts to integrate $f''(x)$ once with one index correct. E.g. $4x \to ...x^2$ or $\frac{1}{\sqrt{x}} \to ...x^{\frac{1}{2}}$

**dM1**: Applies $f'(4)=3$ and solves to find a constant of integration. **Depends on first M1**.

**A1**: $(f'(x)=)2x^2+2x^{\frac{1}{2}}-33$ or obtains $(f'(x)=)2x^2+2x^{\frac{1}{2}}+c$ with $c$ correctly calculated as –33

Ignore labelling of the function e.g. they may call it f ($x$)

**dM1**: **Dependent upon first M1 only**. For an attempt to integrate $f''(x)$ twice and achieve a form $(f(x)=)ax^3+bx^{\frac{3}{2}}+...$ where ... could be 0. Ignore labelling of the function e.g. they may call it f($x$)

**dddM1**: **Dependent upon all previous M's**. It is for using $f(4)=16$ (may be implied) to find the constant of integration.

**A1**: $(f(x)=)\frac{2}{3}x^3+\frac{4}{3}x^{\frac{3}{2}}-33x+\frac{284}{3}$ or exact equivalent. Apply isw once a correct **expression** is seen.