Question Number	Scheme	Marks
8 (a)	$x \geqslant 5,\ x = -4$	M1, A1 **(2)**
(b)	States or implies that $\mathrm{f}(x) = k(\pm x \pm 4)^2(\pm x \pm 5)$ oe	M1
	e.g. substitutes $(0, 20)$ into $\mathrm{f}(x) = k(x+4)^2(x-5) \Rightarrow k = ...$	dM1
	$(\mathrm{f}(x) =) -\frac{1}{4}(x+4)^2(x-5)$ or $(\mathrm{f}(x) =) \frac{1}{4}(x+4)^2(5-x)$	A1 **(3)**
(c)	$x = 5$	B1
	$-\frac{1}{4}(x+4)^2(x-5) = 3x(x-5) \Rightarrow (x-5)\left\{3x + \frac{1}{4}(x+4)^2\right\} = 0$	
	$\Rightarrow (x-5)(x^2+20x+16) = 0$	M1
	$\Rightarrow (x+10)^2 = 84 \Rightarrow x = ...$	dM1
	$x = -10 \pm 2\sqrt{21}$	A1 **(4)** **(9 marks)**

(a) Allow equivalent notation including set or interval notation

M1: For either $x \geqslant 5$ or $x = -4$. May be seen as e.g. $[5, \infty)$ or $\{x \in \mathbb{R} : x \geqslant 5\}$ or condone $x > 5$, or $(5, \infty)$ Allow variations on these as long as the intention is clear.

A1: $x \geqslant 5,\ x = -4$ oe Do not withhold this mark for use of 'and' oe and again allow variations on notation as long as the intention is clear and the inequality $x \geqslant 5$ is correct

(b)

M1: States or implies that $\mathrm{f}(x) = k(\pm x \pm 4)^2(\pm x \pm 5)$ even allowing $k = \pm 1$

dM1: Substitutes $(0, 20)$ into $\mathrm{f}(x) = k(x+4)^2(x-5) \Rightarrow k = ...$ or $\mathrm{f}(x) = k(x+4)^2(5-x) \Rightarrow k = ...$ It is dependent on the previous method mark. May use a different letter to k

A1: $(\mathrm{f}(x) =) -\frac{1}{4}(x+4)^2(x-5)$ oe such as $(\mathrm{f}(x) =) \frac{1}{4}(x+4)^2(5-x)$

Alt(b) Simultaneous equations $y = ax^3 + bx^2 + cx + d$

M1: Attempts to form 3 equations from

$(-4, 0) \Rightarrow 0 = -64a + 16b - 4c + d$

$(5, 0) \Rightarrow 0 = 125a + 25b + 5c + d$

$(0, 20) \Rightarrow d = 20$

$(-4, 0) \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x} = 3ax^2 + 2bx + c \Rightarrow 48a - 8b + c = 0$

dM1: Forms all 4 equations and solves simultaneously to achieve values for a, b, c and d. It cannot be scored for just stating the values via a calculator.

A1: As above in main scheme and notes

(c) Note that B0M1dM1A1 is possible

B1: $x = 5$ seen in part (c)

M1dM1A1 can only be scored if they have a valid answer to part (b) which is of the form $\mathrm{f}(x) = k(x \pm 4)^2(x-5)$

M1: Sets their $-\frac{1}{4}(x+4)^2(x-5) = 3x(x-5)$ and cancels by $(x-5)$ to set up a 3TQ equation or factorises out $(x-5)$ proceeding to e.g. $(x-5)(x^2+20x+16) = 0$ You do not need to be concerned with the mechanics of the rearrangement but the brackets should be expanded and terms collected.

dM1: Correct method of solving their quadratic factor via factorisation, completing the square or the formula (usual rules apply). If the quadratic formula is correctly stated there still has to be evidence of substituting in the values for *a*, *b* and *c* before stating the roots. It is dependent on the previous method mark.
This mark cannot be scored for just stating the roots via a calculator which is dM0A0.

A1: $-10 \pm 2\sqrt{21}$ following M1dM1 isw if they achieve $\frac{-20 \pm \sqrt{336}}{2}$ and then make errors simplifying.

Alternative method – using the factor theorem

e.g. $-\frac{1}{4}(x+4)^2(x-5) = 3x(x-5) \Rightarrow x^3 + 15x^2 - 84x - 80 = 0 \Rightarrow (x-5)(x^2+20x+16) = 0$

$\Rightarrow x = 5,\ x = \frac{-20 \pm \sqrt{20^2 - 4 \times 1 \times 16}}{2 \times 1} = -10 \pm 2\sqrt{21}$

B1: $x = 5$ seen in part (c)

M1: After reaching a cubic form, attempts to factorise out (or divide by) the $(x-5)$ term leading to a 3TQ equation. They cannot just write down the solutions of their cubic from the calculator.

dM1: As above in main scheme notes

A1: As above in main scheme notes

Question Number	Scheme	Marks
9. (a)	20	B1 **(1)**
(b)	$(160°, -1)$	B1 **(1)**
(c)	$x = 3670°, 3850°$	B1, dB1 **(2)**
(d)(i)	$(160°, 4)$	B1ft
(ii)	$(240°, -1)$	B1ft **(2)** **(6 marks)**

Must be in degrees but condone lack of degree symbols throughout.

(a)

B1: 20 (allow if embedded in the equation)

(b)

B1: $(160°, -1)$ Condone missing brackets (one or both). May be written separately $x = 160°,\ y = -1$

(c)

B1: One of $3670°, 3850°$

dB1: Both $3670°, 3850°$ and no others. Cannot be scored without the previous mark being scored.

(d) (i)

B1ft: $(160°, 4)$ OR follow through on their answer to (b). So, accept $(a, b) \rightarrow (a, -4b)$ even where *a* may appear to be an angle in radians as we are looking for *y*-coordinate to change. Condone missing brackets (one or both). May be written separately e.g. $x = 160°,\ y = 4$

(d)(ii)

B1ft: $(240°, -1)$ OR follow through on their answer to (a). So, accept $(180 + 3k, -1)$ with their *k* substituted in. Condone missing brackets (one or both).
May be written separately e.g. $x = 240°,\ y = -1$

Special Case: All 3 of (b) $(-1,\ 160°)$ (d)(i) $(4, 160°)$ (d)(ii) $(-1,\ 240°)$ score (b) B0 (d)(i) B1 (d)(ii) B1