Question	Scheme	Marks	AOs
10(a)(i)	Centre $(-3k,\ k)$	B1	2.2a
(ii)	$(x+3k)^2-9k^2+(y-k)^2-k^2+7=0\Rightarrow(x+3k)^2+(y-k)^2=...$	M1	1.1b
	Radius $\sqrt{10k^2-7}$	A1ft	2.2a
		(3)	
(b)	$x^2+(2x-1)^2+6kx-2k(2x-1)+7=0\Rightarrow...x^2+(pk+q)x+rk+s(=0)$	M1	1.1a
	$5x^2+(2k-4)x+(2k+8)\ (=0)$	A1	1.1b
	$(2k-4)^2-4\times5\times(2k+8)=0\Rightarrow k=...$	dM1	2.1
	Critical values = $7\pm\sqrt{85}$	A1	1.1b
	$k<"7-\sqrt{85}"$ or $k>"7+\sqrt{85}"$ o.e.	ddM1	3.1a
	$k<7-\sqrt{85}$ or $k>7+\sqrt{85}$ o.e.	A1	2.5
		(6)	
		(9 marks)	

Notes

(a)(i)

B1: $(-3k,\ k)$ o.e. Accept without brackets. May be written as $x=-3k,\quad y=k$

(a)(ii)

M1: Attempts to find r^2 by completing the square and collects terms outside the brackets on the other side of the equation. $(x\pm3k)^2-...k^2+(y\pm k)^2-...k^2+7=0\Rightarrow(x\pm3k)^2+(y\pm k)^2=\pm ak^2\pm b$

Alternatively, they may try to use general formulae such as

$x^2+y^2+2fx+2gx+c=0\Rightarrow r^2=f^2+g^2-c$

May also be implied by an expression for *r*.

A1ft: $\sqrt{10k^2-7}$ Condone unsimplified equivalent expressions such as $\sqrt{9k^2+k^2-7}$ and do not allow if this is written with the equation of the circle as $(x+3k)^2+(y-k)^2=10k^2-7$. It must be extracted from this and explicitly written as $\sqrt{10k^2-7}$ o.e.

Do not penalise if their square root does not go fully over all three terms as long as the intention is clear.

Only follow through on a centre of the form $(\pm3k,\ \pm k)$ which will lead to a radius of $\sqrt{10k^2-7}$

Do not allow $\pm\sqrt{10k^2-7}$ and do not isw e.g. if they divide their radius by 2 (thinking they had found the diameter) then A0

(b)

M1: Substitutes $y=2x-1$ into the equation of the circle or their manipulated equation of the circle from (a) and attempts to collect terms proceeding to $.x^2+(pk+q)x+rk+s=0$ where *p*, *q*, *r* and *s* are all non zero.

Condone arithmetical slips and do not be too concerned by the mechanics of their rearrangement.

May be implied by $5x^2+(2k-4)x+2k+8\ (=0)$ or by their values for *a*, *b* and *c* in their discriminant. Do not be concerned with the use of <, > or =

A1: $5x^2+(2k-4)x+2k+8\ (=0)$ (which may be implied by their *a*, *b* and *c* in their discriminant) Do not be concerned with the use of <, > or =

Check carefully the signs of $2k-4$ since $4-2k$ will lead to the same answers and should score maximum M1A0dM1A0ddM1A0

dM1: Attempts to find $b^2 - 4ac$ for their 3TQ and attempts to find at least one critical value. Do not be too concerned by the mechanics of their rearrangement.
If they find the root(s) directly from a calculator you will need to check this. (condone decimals which may be rounded or truncated)
It is dependent on the first method mark. Do not be concerned with the use of <, > or =

A1: $7 \pm \sqrt{85}$

ddM1: Attempts to find the outside region for their critical values. It is dependent on the previous two method marks. (Must have **two values** to be able to score this mark)
States e.g. $k < "7-\sqrt{85}"$, $k > "7+\sqrt{85}"$ (condone $k \geqslant "7+\sqrt{85}"$, $k \leqslant "7-\sqrt{85}"$).
Condone for this mark $x \leftrightarrow k$ and e.g. $"7+\sqrt{85}" \leqslant k \leqslant "7-\sqrt{85}"$. Allow any equivalent expression including set notation which includes both outside regions. Do not penalise poor notation to indicate the outside regions. Condone e.g. "and" o.e for this mark.

A1: $k < 7-\sqrt{85}$ or $k > 7+\sqrt{85}$ or any equivalent expression including set notation which includes **both** outside regions.
e.g. $k < 7-\sqrt{85}$, $k > 7+\sqrt{85}$ $\left(-\infty, 7-\sqrt{85}\right) \cup \left(7+\sqrt{85}, \infty\right)$
$\left\{k : k \in \mathbb{R}, k < 7-\sqrt{85}\right\} \cup \left\{k : k \in \mathbb{R}, k > 7+\sqrt{85}\right\}$.
Allow " ," "or", " $\cup$ " or a space between the answers (or on different line) but do not accept "and", " $\cap$ "
If a variable is used it must be in terms of *k*
Do not allow e.g. "$k < 7-\sqrt{85}$ and $k > 7+\sqrt{85}$" or $\left[-\infty, 7-\sqrt{85}\right] \cup \left[7+\sqrt{85}, \infty\right]$
isw provided there is no contradiction with the correct answer.

Alternative method:
Using the formula for the perpendicular distance of a point from a line via a Further Maths method
Send to review if you are unsure how to mark these

M1: Substitutes the values of $2x - y - 1 = 0$ and $(-3k,\ k)$ into $d = \left|\frac{2(-3k)+(-1)k+(-1)}{\sqrt{2^2+(-1)^2}}\right|$

Condone sign slips.

A1: $(d =)\left|\frac{2(-3k)+(-1)k+(-1)}{\sqrt{2^2+(-1)^2}}\right|$

dM1: Attempts to proceed from $\left|\frac{2(-3k)+(-1)k+(-1)}{\sqrt{2^2+(-1)^2}}\right| < \sqrt{"10k^2-7"}$ to form a 3TQ (typically $k^2 - 14k - 36 > 0$) and attempts to find the critical values as above via any valid method. Do not be concerned with the use of <, > or =

A1ddM1A1: As above