Question	Scheme	Marks	AOs
14 (a)	Attempts to complete the square $(x \pm 3)^2 + (y \pm 5)^2 = \ldots$	M1	1.1b

	(i) Centre $(3,-5)$	A1	1.1b
	(ii) Radius 5	A1	1.1b
		(3)	
(b)	Uses a sketch or otherwise to deduce $k=0$ is a critical value	B1	2.2a
	Substitute $y=kx$ in $x^2+y^2-6x+10y+9=0$	M1	3.1a
	Collects terms to form correct 3TQ $(1+k^2)x^2+(10k-6)x+9=0$	A1	1.1b
	Attempts $b^2-4ac...0$ for their *a*, *b* and *c* leading to values for *k* $''(10k-6)^2-36(1+k^2)...0'' \rightarrow k=...,...$ $\left(0 \text{ and } \frac{15}{8}\right)$	M1	1.1b
	Uses $b^2-4ac>0$ and chooses the outside region (see note) for **their** critical values (Both *a* and *b* must have been expressions in *k*)	dM1	3.1a
	Deduces $k<0, k>\frac{15}{8}$ oe	A1	2.2a
		(6)	
			(9 marks)

Notes

(a)

M1: Attempts $(x\pm3)^2+(y\pm5)^2=$ **..**

This mark may be implied by candidates writing down a centre of $(\pm3,\pm5)$ or $r^2=25$

(i) A1: Centre $(3,-5)$

(ii) A1: Radius 5. Do not accept $\sqrt{25}$

Answers only (no working) scores all three marks

(b)

B1: Uses a sketch or their subsequent quadratic to deduce that $k=0$ is a critical value.
You may award for the correct $k<0$ but award if $k \leqslant 0$ or even with greater than symbols

M1: Substitutes $y=kx$ in $x^2+y^2-6x+10y+9=0$ or their $(x\pm3)^2+(y\pm5)^2=$ **...** to form an equation in just *x* and *k* . It is possible to substitute $x=\frac{y}{k}$ into their circle equation to form an equation in just *y* and *k*.

A1: Correct 3TQ $(1+k^2)x^2+(10k-6)x+9=0$ with the terms in *x* collected. The "= 0" can be implied by subsequent work. This may be awarded from an equation such as $x^2+k^2x^2+(10k-6)x+9=0$ so long as the correct values of *a*, *b* and *c* are used in $b^2-4ac...0$.

FYI The equation in *y* and *k* is $(1+k^2)y^2+(10k^2-6k)y+9k^2=0$ oe

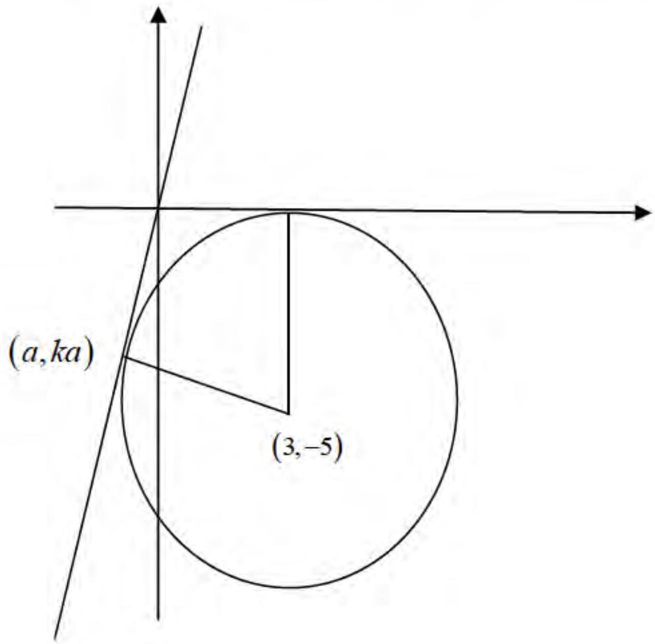
M1: Attempts to find two critical values for *k* using $b^2-4ac...0$ or $b^2...4ac$ where ... could be "=" or any inequality.

dM1: Finds the outside region using their critical values. Allow the boundary to be included. It is dependent upon all previous M marks and both *a* and *b* must have been expressions in *k*.
Note that it is possible that the correct region could be the inside region if the coefficient of k^2 in $4ac$ is larger than the coefficient of k^2 in b^2 Eg.

$$b^2-4ac=(k-6)^2-4\times(1+k^2)\times9>0 \Rightarrow -35k^2-12k>0 \Rightarrow k(35k+12)<0$$

A1: Deduces $k<0, k>\frac{15}{8}$. This must be in terms of k. Allow exact equivalents such as $k<0 \cup k>1.875$ but not allow $0>k>\frac{15}{8}$ or the above with AND, & or $\cap$ between the two inequalities

Alternative using a geometric approach with a triangle with vertices at $(0,0)$, and $(3,-5)$



Alt (b)	Uses a sketch or otherwise to deduce $k=0$ is a critical value	B1	2.2a
	Distance from (a,ka) to $(0,0)$ is $3 \Rightarrow a^2\left(1+k^2\right)=9$	M1	3.1a
	Tangent and radius are perpendicular $\Rightarrow k\times\frac{ka+5}{a-3}=-1 \Rightarrow a\left(1+k^2\right)=3-5k$	M1	3.1a
	Solve simultaneously, (dependent upon both M's)	dM1	1.1b
	$k=\frac{15}{8}$	A1	1.1b
	Deduces $k<0, k>\frac{15}{8}$	A1	2.2a
		(6)	