9a) $x^2 + (3x+7)^2 - 4x - 6(3x+7) - 7 = 0$

$x^2 + 9x^2 + 42x + 49 - 4x - 18x - 42 - 7 = 0$

$10x^2 + 20x = 0$

$10x(x+2) = 0$

$x = 0 \quad x = -2$

$y = 3(0) + 7 \quad y = 3(-2) + 7$

$= 7 \quad = 1$

$(0, 7) \quad (-2, 1)$

b) midpoint $= \left(\frac{0-2}{2}, \frac{7+1}{2}\right) = (-1, 4)$

centre : $(2, 3)$

radius $\sqrt{3^2 + 1^2} = \sqrt{10}$

$(x-2)^2 + (y-3)^2 = 10$

Question			Generic scheme	Illustrative scheme	Max mark
9.	(a)		$\bullet^1$ substitute for y in equation of circle $\bullet^2$ arrange in standard quadratic form $\bullet^3$ factorise $\bullet^4$ state x coordinates $\bullet^5$ state corresponding y coordinates	$\bullet^1$ $x^2+(3x+7)^2-4x-6(3x+7)-7=0$ $\bullet^2$ $10x^2+20x=0$ $\bullet^3$ $10x(x+2)=0$ $\bullet^4$ 0 $\quad$ -2 $\bullet^5$ 7 $\quad$ 1	**5**

Notes:

1. $\bullet^1$ is only available if '$=0$' appears by the $\bullet^3$ stage.
2. At $\bullet^3$, the quadratic must lead to two distinct real roots for $\bullet^4$ and $\bullet^5$ to be available.
3. At $\bullet^3$ do not penalise candidates who fail to extract the common factor or who have divided the quadratic equation by 10.
4. If a candidate arrives at an equation which is not a quadratic at $\bullet^2$ stage, then $\bullet^3$, $\bullet^4$ and $\bullet^5$ are not available
5. $\bullet^3$ is available for substituting correctly into the quadratic formula.
6. $\bullet^4$ and $\bullet^5$ may be marked either horizontally or vertically.
7. Ignore incorrect labelling of P and Q.

Commonly Observed Responses:

Candidate A - substituting for y

$\left(\frac{y-7}{3}\right)^2+y^2-4\left(\frac{y-7}{3}\right)-6y-7=0$ $\bullet^1$ ✓

$\frac{10y^2-80y+70}{9}=0$ $\bullet^2$ ✓

$10(y-1)(y-7)=0$ $\bullet^3$ ✓

$y=1$ or $y=7$ $\bullet^4$ ✓

$x=-2$ or $x=0$ $\bullet^5$ ✓

Question			Generic scheme	Illustrative scheme	Max mark
9.	(b)		$\bullet^6$ state centre of circle $\bullet^7$ calculate midpoint of PQ $\bullet^8$ calculate radius of small circle $\bullet^9$ state equation of small circle	$\bullet^6$ $(2,\ 3)$ $\bullet^7$ $(-1,\ 4)$ $\bullet^8$ $\sqrt{10}$ $\bullet^9$ $(x-2)^2+(y-3)^2=10$	**4**

Notes:

8. Evidence for $\bullet^6$ may appear in part (a).
9. Where a candidate uses coordinates for P and Q without supporting working, $\bullet^7$ is not available, however $\bullet^8$ and $\bullet^9$ may be awarded.
10. Where candidates find the equation of the larger circle $\bullet^8$ and $\bullet^9$ are not available.

Commonly Observed Responses:

Candidate B - using substitution

Equation of smaller circle of form

$(x-2)^2+(y-3)^2=r^2$ $\bullet^6$ ✓

Midpoint PQ $(-1,\ 4)$ $\bullet^7$ ✓

$(-1-2)^2+(4-3)^2=r^2$

$r^2=10$ $\bullet^8$ ✓

$(x-2)^2+(y-3)^2=10$ $\bullet^9$ ✓

Candidate C - using tangency

Equation of smaller circle of form

$(x-2)^2+(y-3)^2=r^2$ $\bullet^6$ ✓

Since $y=3x+7$ is tangent to smaller circle

$10x^2+20x+20-r^2=0$ has equal roots

$\Rightarrow 20^2-4(10)(20-r^2)=0$ $\bullet^7$ ✓

$\Rightarrow r^2=10$ $\bullet^8$ ✓

$(x-2)^2+(y-3)^2=10$ $\bullet^9$ ✓

Candidate D - using P or Q to mid-point as radius

⋮

$r=\sqrt{(-2+1)^2+(1-4)^2}=\sqrt{10}$ $\bullet^8$ ✗

or

$r=\sqrt{(0+1)^2+(7-4)^2}=\sqrt{10}$ $\bullet^8$ ✗

$(x-2)^2+(y-3)^2=10$ $\bullet^9$ ✓ 2