(10) (a) $2g = 18$ $\quad 2f = -2$

$g = 9 \quad f = -1 \quad$ Centre $(-9, 1)$

$$r = \sqrt{g^2 + f^2 - c}$$
$$= \sqrt{9^2 + (-1)^2 - (-8)}$$
$$= \sqrt{81 + 1 + 8}$$
$$= \sqrt{90}$$
$$= \sqrt{9 \times 10}$$
$$= 3\sqrt{10}$$

(b) Let d = distance between centres.

$$d = \sqrt{(-9-(-6))^2 + (1-0)^2}$$
$$= \sqrt{3^2 + 1^2}$$
$$= \sqrt{10}$$

$$d = r_1 - r_2$$
$$\sqrt{10} = 3\sqrt{10} - r_2$$
$$\therefore r_2 = 2\sqrt{10}$$

$$(x+6)^2 + (y-0)^2 = (2\sqrt{10})^2$$
$$(x+6)^2 + y^2 = 40$$

(11) (a) When $t = 0$, $N = 6.8e^0 = 6.8$

Number of vehicles = 6.8 million (or 6 800 000)

(b) $$125 = 6.8e^{10k}$$
$$e^{10k} = \frac{125}{6.8}$$
$$10k = \ln\left(\frac{125}{6.8}\right)$$
$$k = \frac{1}{10}\ln\left(\frac{125}{6.8}\right)$$
$$= 0.29113\ldots \approx 0.291$$

Question			Generic scheme	Illustrative scheme	Max mark
10.	(a)		$\bullet^1$ state centre $\bullet^2$ calculate radius	$\bullet^1$ $(-9,1)$ $\bullet^2$ $\sqrt{90}$ or $3\sqrt{10}$ or 9.48…	**2**

Notes:

1. Accept $x=-9,\ y=1$ for $\bullet^1$.
2. Do not accept '$g=-9, f=1$' or '$-9,1$' for $\bullet^1$.
3. Do not penalise candidates who treat negative signs with a lack of rigour when calculating the radius. For example accept $\sqrt{9^2+-1^2+8}=\sqrt{90}$ or $\sqrt{9^2+1^2+8}=\sqrt{90}$ or $\sqrt{-9^2+1^2+8}=\sqrt{90}$ for $\bullet^2$. However, do not accept $\sqrt{9^2-1^2+8}=\sqrt{90}$ for $\bullet^2$.

Commonly Observed Responses:

Question			Generic scheme	Illustrative scheme	Max mark
	(b)		$\bullet^3$ determine the distance between the centres and subtract to find a numerical expression for the radius of C_2 $\bullet^4$ determine equation of C_2	$\bullet^3$ eg $\sqrt{90}-\sqrt{10}$ $\bullet^4$ $(x+6)^2+y^2=40$	**2**

Notes:

4. Do not penalise the use of decimals.
5. The distance between the centres, and the radius of C_2 must be consistent with the sizes of the circles in the original diagram ($d<r_{C_2}<r_{C_1}$).
6. Where a candidate uses an incorrect radius without supporting working, $\bullet^4$ is not available.

Commonly Observed Responses:

Candidate A - follow-through marking

Part (a)

$r=\sqrt{74}$ $\quad\bullet^2$ ✗

Part (b)

$d=\sqrt{10}$

radius $=\sqrt{74}-\sqrt{10}$ $\quad\bullet^3$ ✓1

$(x+6)^2+y^2=5.44\ldots^2$

$(x+6)^2+y^2=29.59\ldots$ (or $84-4\sqrt{185}$) $\quad\bullet^4$ ✓1

Candidate B - using line through centres

Equation of radius: $3y=-x-6$

$(-3y-6)^2+y^2+18(-3y-6)-2y-8=0$

$10y^2-20y-80=0$

$\cancel{y=4}$ $\quad y=-2$

$\cancel{x=-18}$ $\quad x=0$

Radius = distance between $(-6,0)$ and $(0,-2)$

Radius = $\sqrt{40}$ $\quad\bullet^3$ ✓

$(x+6)^2+y^2=40$ $\quad\bullet^4$ ✓