(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 |
|---|---|---|---|---|---|
| **11.** | (a) | | $\bullet^1$ state number of vehicles | $\bullet^1$ 6.8 million | **1** |
| **Notes:** | | | | | |
| 1. Accept 6.8 or $N = 6.8$ million for $\bullet^1$. | | | | | |
| **Commonly Observed Responses:** | | | | | |
| | | | | | |
| | (b) | | $\bullet^2$ substitute for $N$ and $t$<br><br>$\bullet^3$ process equation<br><br>$\bullet^4$ express in logarithmic form<br><br>$\bullet^5$ solve for $k$ | $\bullet^2$ $125 = 6.8e^{10k}$ stated or implied by $\bullet^3$<br><br>$\bullet^3$ $\frac{125}{6.8} = e^{10k}$<br><br>$\bullet^4$ $\log_e\left(\frac{125}{6.8}\right) = 10k$<br><br>$\bullet^5$ 0.2911... | **4** |
| **Notes:** | | | | | |
| 2. Accept answers which round to 0.29.<br>3. Do not penalise rounding or transcription errors (which are correct to 2 significant figures) in intermediate calculations.<br>4. $\bullet^3$ may be assumed by $\bullet^4$.<br>5. Any base may be used at $\bullet^4$ stage. See Candidate A.<br>6. At $\bullet^4$ all exponentials must be processed.<br>7. Accept $\log_e \frac{125}{6.8} = 10k \log_e e$ for $\bullet^4$.<br>8. The calculation at $\bullet^5$ must follow from the valid use of exponentials and logarithms at $\bullet^3$ and $\bullet^4$.<br>9. For candidates with no working, or who adopt an iterative approach to arrive at $k = 0.29$, award 1/4. However, if, in the iterations $N$ is calculated for $k = 0.295$ and $k = 0.285$, then award 4/4. | | | | | |
| **Commonly Observed Responses:** | | | | | |
| **Candidate A - use of alternative base**<br>$125 = 6.8e^{10k}$ $\bullet^2$ ✓<br>$\frac{125}{6.8} = e^{10k}$ $\bullet^3$ ✓<br>$\log_{10}\left(\frac{125}{6.8}\right) = 10k \log_{10} e$ $\bullet^4$ ✓<br>$k = 0.2911...$ $\bullet^5$ ✓ | | | **Candidate B - missing lines of working**<br>$125 = 6.8e^{10k}$ $\bullet^2$ ✓<br>$k = 0.2911...$ $\bullet^3$ ^ $\bullet^4$ ^ $\bullet^5$ ✓ | | |
| **Candidate C - errors in substitution**<br>$125000000 = 6.8e^{10k}$ $\bullet^2$ ×<br>$\frac{125000000}{6.8} = e^{10k}$ $\bullet^3$ $✓_1$<br>$16.726... = 10k$ $\bullet^4$ $✓_1$<br>$k = 1.6726...$ $\bullet^5$ $✓_1$ | | | | | |