**Marks 4**

- The data given in the table below were obtained for the reaction between nitric oxide and chlorine at 1400 K.

$$2NO(g) + Cl_2(g) \rightarrow 2NOCl(g)$$

| Experiment number | INITIAL $[Cl_2]$ ($mol^{-1}$ $L^{-1}$) | INITIAL [NO] ($mol^{-1}$ $L^{-1}$) | INITIAL REACTION RATE ($mol^{-1}$ $L^{-1}$ $s^{-1}$) |
|---|---|---|---|
| 1 | 0.10 | 0.10 | 0.18 |
| 2 | 0.20 | 0.10 | 0.36 |
| 3 | 0.10 | 0.20 | 0.72 |

Deduce the rate law for this reaction and calculate the value of the rate constant.

| RATE LAW | RATE CONSTANT |
|---|---|
| **Between experiments (1) and (2), [NO] is fixed and $[Cl_2]$ is doubled. This leads to the rate doubling:** <br> **rate α $[Cl_2]^1$.** <br> **Between experiments (1) and (3), $[Cl_2]$ is fixed and [NO] is doubled. This leads to the rate increasing by a factor of 4:** <br> **rate α $[NO]^2$.** <br> **Overall,** <br> **rate = $k[NO]^2[Cl_2]$.** | **Using this rate law and the rate from experiment (1),** <br> **$0.18$ M $s^{-1}$ = $k(0.10\ M)^2(0.10\ M)$** <br> **Hence,** <br> **$k$ = 180 $M^{-2}$ $s^{-1}$** <br> **The units of $k$ are such that the units of the left and right hand sides of the equation are the same:** <br> **M $s^{-1}$ = (units of $k$)($M^2$)(M)** <br> **units of $k$ = $M^{-2}$ $s^{-1}$** |
| Answer: **rate = $k[NO]^2[Cl_2]$** | Answer: **rate constant = 180 $M^{-2}$ $s^{-1}$** |