

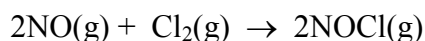
- What are allotropes? Give an example of a pair of allotropes involving carbon and a second example of a pair not involving carbon.

**Marks**  
**3**

**Allotropes are different molecular forms of the same element. Examples include graphite, diamond and buckminsterfullerene for carbon, white and red phosphorus and O<sub>2</sub> and O<sub>3</sub> for oxygen.**

- The following data were obtained for the reaction between gaseous nitric oxide and chlorine at 1400 K.

**4**



EXPERIMENT NUMBER	INITIAL [NO] (mol L <sup>-1</sup> )	INITIAL [Cl <sub>2</sub> ] (mol L <sup>-1</sup> )	INITIAL REACTION RATE (mol L <sup>-1</sup> s <sup>-1</sup> )
1	0.10	0.10	0.18
2	0.10	0.20	0.36
3	0.20	0.10	0.72

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

RATE LAW	RATE CONSTANT
<p><b>In experiments 1 and 2, [NO] is kept constant. Doubling [Cl<sub>2</sub>] doubles the rate so the reaction is first order with respect to [Cl<sub>2</sub>].</b></p> <p><b>In experiments 1 and 3, [Cl<sub>2</sub>] is kept constant. Doubling [NO] leads to the rate increasing by a factor of four so the reaction is second order with respect to [NO].</b></p> <p><b>Therefore:</b></p> <p><b>rate <math>\propto</math> [NO]<sup>2</sup>[Cl<sub>2</sub>]</b></p> <p><b>rate = <math>k</math>[NO]<sup>2</sup>[Cl<sub>2</sub>]</b></p>	<p><b>From experiment 1 and the rate law,</b></p> $\text{rate} = k[\text{NO}]^2[\text{Cl}_2]$ $k = \frac{\text{rate}}{[\text{NO}]^2[\text{Cl}_2]} =$ $= \frac{(0.18 \text{ mol L}^{-1} \text{ s}^{-1})}{(0.10 \text{ mol L}^{-1})^2 (0.10 \text{ mol L}^{-1})}$ $k = 180 \text{ mol}^{-2} \text{ L}^2 \text{ s}^{-1}$ <p><b>The units can be deduced from the rate law and the units of the rate (mol L<sup>-1</sup> s<sup>-1</sup>) and the concentrations (mol L<sup>-1</sup>):</b></p> $\text{units of } k = \frac{\text{mol L}^{-1} \text{ s}^{-1}}{(\text{mol L}^{-1})^2 (\text{mol L}^{-1})}$ <p><b>units of <math>k</math> are mol<sup>-2</sup> L<sup>2</sup> s<sup>-1</sup></b></p>
<p><b>Answer: rate = <math>k</math>[NO]<sup>2</sup>[Cl<sub>2</sub>]</b></p>	<p><b>Answer: <math>k = 180 \text{ mol}^{-2} \text{ L}^2 \text{ s}^{-1}</math></b></p>