# Alkanes

## Question Paper 3

| Level | International A Level |
|---|---|
| Subject | Chemistry |
| Exam Board | CIE |
| Topic | Hydrocarbons |
| Sub-Topic | Alkanes |
| Paper Type | Theory |
| Booklet | Question Paper 3 |

Time Allowed:       **18 minutes**

Score:              **/15**

Percentage:         **/100**

**Grade Boundaries:**

| A* | A | B | C | D | E | U |
|---|---|---|---|---|---|---|
| >85% | 777.5% | 70% | 62.5% | 57.5% | 45% | <45% |

**1** When hydrocarbons such as petrol or paraffin wax are burned in an excess of air in a laboratory, carbon dioxide and water are the only products.
When petrol is burned in a car engine, nitrogen monoxide, NO, is also formed.

**(a)** Explain how NO is formed in an internal combustion engine but not formed when a small sample of petrol is burnt in an evaporating basin.

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The engines of modern motor cars have exhaust systems which are fitted with catalytic converters in order to reduce atmospheric pollution from substances such as NO.

**(b) (i)** State **three more** pollutants, other than $CO_2$ and $H_2O$, that are present in the exhaust gases of a car engine.

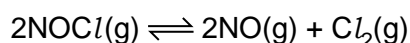.................................... and .................................... and ...........................................

**(ii)** What is the active material present in the catalytic converter?

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**(iii)** Write **one** balanced equation to show how NO is removed from the exhaust gases of a car engine by a catalytic converter.

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[4]

NO is also formed when nitrosyl chloride, $NOCl$, dissociates according to the following equation.

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

Different amounts of the three gases were placed in a closed container and allowed to come to equilibrium at 230 °C. The experiment was repeated at 465 °C.

The equilibrium concentrations of the three gases at each temperature are given in the table below.

| temperature /°C | concentration / mol dm$^{-3}$ | | |
|---|---|---|---|
| | $NOCl$ | NO | $Cl_2$ |
| 230 | $2.33 \times 10^{-3}$ | $1.46 \times 10^{-3}$ | $1.15 \times 10^{-2}$ |
| 465 | $3.68 \times 10^{-4}$ | $7.63 \times 10^{-3}$ | $2.14 \times 10^{-4}$ |

**(c)** **(i)** Write the expression for the equilibrium constant, $K_c$, for this reaction. Give the units.

**(ii)** Calculate the value of $K_c$ at each of the temperatures given.

230 °C

465 °C

**(iii)** Is the forward reaction endothermic or exothermic? Explain your answer.

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[5]

**(d)** The temperature of the equilibrium was then altered so that the equilibrium concentrations of NOC*l* and NO were the same as each other.

What will be the effect on the equilibrium concentration of NOC*l* when the following changes are carried out on this new equilibrium? In each case, explain your answer.

**(i)** The pressure of the system is halved at constant temperature.

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**(ii)** A mixture of NOC*l*(g) and NO(g) containing equal numbers of moles of each gas is introduced into the container at constant temperature.

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[4]

[Total: 15]