Sn and Si Chlorides

A Level

C C C

Tin can form a wide variety of neutral and anionic species with chlorine. For each of the species below, deduce its shape.

Part A $SnCl_2$

$SnCl_2$ (gas phase).

Part B $SnCl_3^-$

$SnCl_3^-$

Part C $SnCl_4$

$SnCl_4$

Part D $SnCl_6^{2-}$

$SnCl_6^{2-}$

Part E $\mathrm{R-Cl}$ bonds

$\mathrm{Si-Cl}$ bonds are susceptible to hydrolysis. For example, $(\mathrm{CH_3})_3\mathrm{SiCl}$ may be hydrolysed to give $(\mathrm{CH_3})_3\mathrm{SiOH}$ which self-condenses to give $(\mathrm{CH_3})_3\mathrm{SiOSi(CH_3)_3}$. Hydrolysis of $(\mathrm{CH_3})_2\mathrm{SiCl_2}$ occurs in a similar way. However, the subsequent self-condensation yields a polymer with repeat unit $\mathrm{[Si(CH_3)_2O]}_n$

Suggest a structure for the intermediate in polymer formation.

Use the structure editor to generate a SMILES string.

Part F Side product

As well forming a polymer, hydrolysis of $(\mathrm{CH_3})_2\mathrm{SiCl_2}$ yields a liquid with empirical formula $\mathrm{C_6H_{18}O_3Si_3}$.

Suggest a structure for this compound.

Use the structure editor to generate a SMILES string.

Adapted with permission from OCLES, STEP Chemistry, June 1997, Question 4.

Oxidation of Vanadium

A Level

C C C

A $0.0100\,\mathrm{mol}$ sample of an oxochloride of vanadium, VOCl_x, required $20.0\,\mathrm{cm}^3$ of $0.100\,\mathrm{mol\,dm}^{-3}$ acidified potassium manganate(VII) for oxidation of the vanadium.

Part A Moles of electrons

How many moles of electrons were removed by the $\mathrm{MnO_4}^-$ ions?

Part B Change in oxidation state

By how much did the oxidation state of vanadium change? Enter, for example, -2 if it went down by two, +2 if it went up by two, 0 if it did not change.

Part C Value of x

What is the value of x in the formula VOCl_x?

Adapted with permission from UCLES, A-Level Chemistry, June 1993, Paper 2, Question 2.

Gameboard:

STEM SMART Chemistry Week 49 (extension)

Gas with Fluorine Reactions

A Level

C C C

A $0.585\,\mathrm{g}$ sample of a colourless, neutral, monatomic gas **A** occupies a volume of $100\,\mathrm{cm^3}$ at s.t.p. When $1.310\,\mathrm{g}$ of **A** are treated with fluorine at $400\,^\circ\mathrm{C}$, the only product is $2.065\,\mathrm{g}$ of a white solid **B** (melting point, $117\,^\circ\mathrm{C}$). When this white solid is treated with dioxygen difluoride, oxygen gas is given off and $2.446\,\mathrm{g}$ of another white solid **C** (melting point, $50\,^\circ\mathrm{C}$) are formed.

When a mixture of **A** and fluorine is irradiated with a mercury vapour lamp at room temperature, a third white solid **D** (melting point, $129\,^\circ\mathrm{C}$) can be isolated. When $0.845\,\mathrm{g}$ of **D** is added to water, there is a brisk effervescence and the resulting solution requires $100\,\mathrm{cm^3}$ of $0.100\,\mathrm{mol\,dm^{-3}}$ $\mathrm{NaOH\,(aq)}$ for neutralisation.

Part A Gas A

What is the likely identity of gas **A**?

Part B Solid B

What is the formula of white solid **B**?

Part C Solid C

What is the formula of white solid **C**?

Part D Solid D

What is the formula of white solid **D**?

Part E B shape

By using electron-pair repulsion theory, predict the shape of **B**.

Part F C shape

By using electron-pair repulsion theory, predict the shape of **C**.

Part G D shape

By using electron-pair repulsion theory, predict the shape of **D**.

Adapted with permission from UCLES, A-Level Chemistry, November 1991, Special Paper, Question 6.

Gameboard:

STEM SMART Chemistry Week 49 (extension)

Aluminium Hydrides

A Level

Solutions of lithium hydride and aluminium chloride in ethoxyethane are mixed together and the resultant white precipitate filtered off. The filtrate is carefully evaporated to dryness and white crystals, **A**, are obtained. They contain: $\mathrm{Li}\ 18.2\,\%$, $\mathrm{Al}\ 71.2\,\%$, $\mathrm{H}\ 10.6\,\%$ by mass.

A reacts violently with water, producing hydrogen gas and a white precipitate.

Part A Compound A

Suggest the identity of **A**.

Part B Formation of A

Write an equation for the formation of **A**. State symbols are not required.

Part C Reaction of A with water

Write an equation for the reaction of **A** with water. State symbols are not required.

Part D $\mathrm{Al-Mg}$ alloy

An alloy of aluminium and magnesium is used in boat-building. A $1.75\,\mathrm{g}$ sample of the alloy was dissolved in the minimum volume of $4\,\mathrm{mol\,dm^3}$ hydrochloric acid and the solution was then made alkaline by the addition of aqueous sodium hydroxide until no further reaction occurred. The resultant mixture was filtered and the residue, **B**, rinsed with distilled water, all washings being added to the filtrate, **C**. After air drying, $0.18\,\mathrm{g}$ of **B** was obtained. Carbon dioxide was passed into **C** and a white solid, **D**, which contained aluminium, was collected. Heating **D** to constant mass gave a residue of mass $3.16\,\mathrm{g}$.

Determine the percentage of aluminium by mass in the alloy to the nearest $\%$.

Adapted with permission from UCLES, A-Level Chemistry, November 1995, Special Paper, Question 4.